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PLATES.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

NINETY-FIRST SESSION.

PRESIDENT'S ADDRESS.

I.—*On the Work of the Philosophical and other Scientific Societies.* By John Ferguson, LL.D., F.R.S.E., F.C.S., Professor of Chemistry in the University of Glasgow, and President of the Society.

[Read before the Society, 1st November, 1893.]

At the opening of a new session of the Society, it falls to the lot of the President to offer to you such thoughts as will lead you to take as broad a view as possible of the work which the Society performs, and to induce others to join in that work, as far as it is in his capacity to do.

A dozen years ago our then President—the late Dr. Fergus—chose as the theme of an introductory address, "The First Five Years of the Society, as ascertained from the Minute Books." While perusing these interesting extracts, which you will find in Vol. XIII., pp. 1-20, three points, more particularly, have appealed to me in my present position of having to inaugurate the session. These are: The original motive of the founders of the Society, the *personnel* of the Society, and the name of the Society.

The motive put forward was "prosperity of trade and manufactures," "improvement of the Arts and Sciences." Such a programme as that may be dealt with in a wide or a narrow spirit. I think it could be shown from the *Proceedings*, that while the views taken of these topics have come and gone, they have always been liberal, and at the present moment tend to enlarge still more rather than the reverse. This generous treatment has all along preserved the Society from becoming one-sided or technical.

The *personnel* of the sixty (?) original members shows that at the very outset a narrow interpretation of the words of the initiatory circular was not entertained. For although we find the majority of the names to be of those who were directly and distinctly "interested in the prosperity of the trade and manufactures of this country, and anxious for the improvement of the Arts and Sciences," there are a few who certainly could not be said to be so because of their own immediate or personal concern therein. The names, for example, of Dr. Patrick Cumin, Professor of Oriental Languages; of the engraver, Haldane; of the architect, Hamilton; of Dr. Towers, Professor of Obstetrics; of Dr. Menteith, and, possibly of some others, make us suppose that they at least became members of the newly-formed Society for general interest in culture, and not for either trade or manufacturing reasons.

In the third and last place, the name of the Society has been a fortunate one in being not only comprehensive but elastic as well. The use of the words philosophy and philosophical to denote the scientific study of natural phenomena in the first instance, and of their practical application in the second, is consecrated by long usage, and is justified by sound sense. It was the criticism, it is said, of a German speculator, or, if that word be rather too restricted in its meaning now-a-days (shall we say?), "speculative thinker," that after looking through volumes of the *Philosophical Transactions*—or was it the *Philosophical Magazine*?—he had found no philosophy. It is supposed that he meant to be satirical at the expense of the English incapacity for, or ignorance of, metaphysical notions, whereas it only shows that he was not aware that the word has different meanings in the two languages, and in his ignorance thought that his use of the word was the only correct one. Perhaps, too, he did not consider that a philosophy which consists in speculation is hardly entitled to the name, and that the speculative thinker, like the speculative financier, is not always a safe guide to sound results. The name, however, has had this advantage, that it has been able to include all the subjects which fall within the purview of the Society, and, as I could show, has become more advantageous with the advances and requirements of quite recent years.

From the very beginning, therefore, our Society was catholic in its actual aims, in the interests of its various members, and in its name.

In consequence of this freedom from restriction to one subject, or set of subjects, it has been able to give opportunity for the discussion of all sorts of topics, though on this account it may have lost, to some extent, the thoroughness and homogeneousness of societies which are concerned with only one branch of knowledge. But a glance backward over its history, as we can gather it from the *Proceedings* (which, having been begun only in 1843, represent, unfortunately, just one-half of the Society's existence), shows that this catholicity has not been detrimental to it. Without trenching on the opportunity which will be afforded to some one, my successor in office a few years hence, to describe in detail the 100 years' work of the Society, there are one or two aspects in the development of it which appeal to one on wider grounds. In running over the volumes of the *Proceedings* one can detect the way of the progress of science in general.

From time to time the subjects that engross the attention of the members change. Influenced by the general advance of scientific discovery and practical applications, certain themes come more frequently to the front than others; and, after they have been pretty well thrashed out, they give way to others, which undergo a similar process. How much, however, depends upon those who treat these subjects, will be seen by reference to the *Proceedings.* It is they who, by their interest, stimulate that of others, and induce them to follow out similar lines of inquiry. Upon discovery follows the era of criticism. The ground of previous investigators is traversed again, errors or flaws are noticed, controversy and discussion result, and at last the truth is placed on a wider basis than before. The earlier discoveries are no longer novelties which surprise and delight us, they are merely commonplace tools which we employ for other purposes. Davy was in such rapture when he got his pin-head of potassium and sodium that he danced for joy in his laboratory. His feelings would be very different now if he could see sodium—the separation of which made his reputation as a discoverer—manufactured not as a scientific marvel, not for its own sake, but merely as a means of getting another metal.

In the early years of the Society, and almost down to 1850, chemistry and mineralogy seem to have been, on the whole, the most popular subjects brought before it. This was just prior to the foundation of the London Chemical Society, and the falling

off, in more recent years, of technical, chemical, and mineralogical papers is due undoubtedly to the great growth of that society, and to the foundation of the Society of Chemical Industry, with local branches, and of the Mineralogical Society. Such societies, affording the specialist a more skilled, responsive, critical audience, naturally attract to themselves all that is novel and best in the branches which they respectively cultivate. There was also some engineering and physics, a little physiology, and a fair representation of botany. The latter science has always had an enthusiastic knot of students in Glasgow; and though the foundation of the Natural History Society and of Field Clubs has tended to absorb the botanists, this Society has never been altogether without some share in botanical progress.

About 1850, geology began, in its turn, to attract the attention of the members. Local geologists brought their results to the Society; but here, again, the nucleus of geologists ultimately hived off from this Society and formed one of their own, where they could discuss the questions in which they felt most interest without having to consider whether they were excluding other subjects or not.

In recent years practical topics have, to some extent, superseded theoretical or purely descriptive ones. We have heard much of sewage and sanitation, because the questions therewith connected were of general and immediate interest. African travel has come before us in various shapes—an attractive subject from every point of view, and not least from that of the founders of our Society, as it concerns "trade and manufactures." We have had even more technical discussions on "profits," "wages," and "workers," which form certain of the social and political problems of the moment. The very last volume of the *Proceedings* illustrates, as clearly as may be, what is the present trend of thought and observation among the members of the Society. Geography and commerce in Africa and Peru, exhaustion of coal and the more economical use of fuel, electric meters, the telephone and batteries, and some economic questions, are just among the themes which concern, not merely our Society, but a very large proportion of the public.

In this way the Philosophical Society has kept abreast of the interests of successive decades, and though it has parted with one set of specialists after another, and may part with others in years to come, it has still plenty of work to do, and it is still as free as

ever to receive a communication on any scientific or technical subject, even of the most abstruse kind.

One may regret the separation of one class of scientific students from another, and would prefer to see a combination of them all to form a single powerful Glasgow Society or Academy, even if those who were its Fellows continued to hold sectional meetings. Consideration, however, of other societies, similar to our own in their original aim, shows that such a process of evolution and specialisation, though not necessarily of isolation, is natural and inevitable. Even the oldest and most illustrious society in the country—the Royal—has seen special societies grow up around it. Yet, although these all are actively engaged in investigation, the Royal Society still obtains some of the best scientific work that is produced. A glance, however, at the *Philosophical Transactions* will show that the range is narrowed down considerably, compared with the much wider one that the society has taken in the past years of its existence, when it not only published original matter on every topic, but reviewed scientific publications as well. This part also of the society's work has been taken out of its hands, and is executed in special journals and reviews, though not unfrequently by its own Fellows. As in our *Proceedings*, but for two hundred and fifty years instead of for only about one hundred, the course of science is displayed in the *Philosophical Transactions*. Men of note, the scientific leaders of their time, forced upon the attention of their contemporaries their discoveries, their theories, the laws of nature which they codified, the practical applications which flowed from their work.

We need not, however, limit our view even to the respectable length of life of the Royal and one or two other European societies and academies. We may ask how science progressed before men, in the desire for knowledge, combined for mutual assistance and consultation.

My immediate predecessor in this chair took, as the theme of an address to the Society, a chronology or synopsis of men of science during the interval from 1460 to 1860. His special object was to show the various steps in the development of anatomy and physiology, elucidating the movements of the time by reference to other branches of science, to literature, and to the fine arts; and he has thus, for a still longer period, furnished material which serves the same historical purpose as that which I have indicated in the life-time of our own Society. In the earlier

centuries of this epoch, the scientific list is comparatively meagre, and that of literature is much more extensive. At the end of the period, thirty years ago, things are much more evenly balanced between those two great branches of human pursuit. The discoveries in science, the methods, the arguments, the deductions, have forced their way in spite of active opposition and crass indifference. Dr. M'Kendrick, in his paper, necessarily confined his attention to the men already indicated as those whose discoveries were more or less of an epoch-making character. These are the men who, at a given period, lead the way and show what is; they discover the truth and rectify the mistakes of past times. Of such men it may be said, that the history of their work is the history of the science while they are actively prosecuting it.

But, as the late historian of England, John Richard Green, demonstrated, there is history of peoples, as well as of kings and courts,—a history of slow growth and development, of habit and custom, of beliefs and doubts, as well as of wars and invasions, of revolutions and conspiracies, of diplomacy and treaties, of ministers and parties.

What is true of social history is also true of science. While the leaders of science, down, say, to the middle of the present century, were busy pursuing investigations to ascertain the truth of nature, the people had a kind of science of their own, if it could be called such: a body of beliefs, ill-founded, misleading, erroneous, traditional, unchanging, which was their knowledge of nature. Whatever discoveries were made, people did not listen or comprehend; they held by their old notions; and there were popular books of science giving one kind of exposition, while the scientific books gave another.

It is a very common belief that there was no interest in nature worth calling by the name much before our own time. There could hardly be a greater mistake. That there was no scientific investigation, in the "1893" use of the word, one may freely admit, and one may be quite ready also to believe that, in the year 1993, our present most advanced science will be quite out of date. It must not be denied, however, that, as far as men's powers had been trained, they were used in a scientific way; but, whether or not, there is not the slightest doubt of the interest felt in physical and natural and technical knowledge from the earliest times. The amount of the older literature is the best answer to any doubts

that may be entertained on this point. It is quite erroneous to suppose that treatises on natural knowledge and on technical receipts were few in number and of no practical importance, or that the ordinary reader felt no concern with the inventions of earlier times and discoveries in the outer world. Until, by accident, I had my attention directed to this subject and to its literature, I thought it was of limited extent and of quite inferior interest. I was wrong. The literature extends far beyond the limits that I should ever have assigned to it, and, judging from it, the demand by the people for practical knowledge must have been widespread, and must have been very real. In lists and descriptions which I have read to this and other societies I have endeavoured to show how keen the desire for knowledge of natural things and their uses has been for at least 600 years.

Let me try to indicate to you certain of the directions in which this popular interest has run, as distinguished from scientific inquiry.

It is a most difficult thing—for the majority of people an impossible thing—to have a critical knowledge of new discoveries or of their applications. Even now all that can be said is that people *accept* them, not because they can check the accuracy or truth of them, but because, if they are in physical science, they can see that they lead to important practical results. Everybody understands the benefits of electric lighting. Even Glasgow philosophers now assembled would appreciate my remarks none the less, perhaps all the more, if we had in this room electric light, instead of what passes for coal-gas illumination now-a-nights in Glasgow; but, of all the thousands who are perambulating Sauchiehall Street at the present moment, how few care what the electric light is so long as they can see their way better; how very few know what long years of painful study of abstract science it has taken for it to have been brought to whatever excellence it may now have, or what was the initial step, or who made it, and by whom it has been carried out; and how fewest of all are those who can criticise it or pass an opinion on it which would be worth listening to as of a kind to remove errors, or to make any part of the whole complex arrangements better than they are.

It is the few science students who, in such a case, have to take upon their shoulders the ignorance of the many,—an ignorance that is never removed, for science always becomes more and more recondite and technical in its language, and in its mode of regarding

things, and withdraws more and more from the ken of the non-scientific. Without immediate tangible results, therefore, the greatest discovery remains for the majority of mankind of no interest. Scientific truth has forced its way into the minds and education of us moderns, not so much because it is *true* as because it is *real;* because it leads to some obvious reality. Abstract truth of science can be only for the few; they alone are educated up to the point of appreciating it. Men who do not or cannot understand science will not be affected by it, except when they see the truths displayed in practical issues. When they are informed of a new discovery the first question they ask is: "What is the use of it?" This question is the shibboleth of the unscientific.

The science of the people—that is to say, of the average educated and reading man or woman of to-day—does little more than deal with results; a critical judgment based upon facts investigated by themselves is, from the nature of the case, almost an impossibility. A man engaged all day in a profession or business may, for relaxation, or from true and genuine interest to know what is going on in some department of thought, turn to a work in which these results are expounded by the best writer on the subject. He is carried away by the skill with which the facts are arranged, and the seeming inevitable necessity with which the conclusions grow out of these facts. He forgets, possibly, that the subject may be controversial, and that, on the opposite side, there may be as formidable an array of facts, with as cogent and irresistible conclusions, as those by which he has just been persuaded. If he reads both sides, he is bewildered. "*Where* is the truth?" he naturally inquires. He is unable, without labour beyond his opportunities, to convince himself by his own inquiries where the truth is—in either, or both, or neither. *That* he must leave to the special inquirer; and, if he has the critical spirit, he will suspend his judgment, and not become a blind adherent of scientific or philosophic gospellers.

Now, if in these days, when criticism is unfettered and investigation is at a premium, our sciences still show so many blanks, our philosophies are still so antagonistic, our arts are still so empirical, and our manufacturers are still such sticklers for the good old rules-of-thumb, what could have been the state of things when there were notions, but no science, at least in our understanding of the term, when there was no essential connection between such notions as there were and the arts, and when the

latter were entirely empirical? We can find an answer if we examine the literature of the arts and sciences which has come down to us from those times.

When one pursues through former epochs down to the present the slow development of scientific ideas and scientific practice, one gains a better notion of the position in which we are now placed. Besides being in advance of what has been done and thought before—small credit to us for seeing further than the giant who is holding us high up,—we take views of natural phenomena different in kind from what have prevailed in the past.

Any one who wishes to prove the truth of this need only dip into a treatise on any branch of science with which he is familiar, written fifty or sixty, or even fewer years ago. Not only the facts current at the time are now superseded or unknown, but the method of dealing with them and the theories are as strange as the facts. It is like an entirely new subject to the reader, like a new language. One has to put off one's modern habit and get into the old-fashioned costume of one's grandfather, and then one finds that it does not fit comfortably, and that one is in a sort of fancy dress.

The further back one goes, the less familiar the subject becomes, until at last it requires as much of an effort to master the principles of science current four hundred or five hundred years ago, as it is for the candidate to cram for an examination at the most *fin-de-siècle* university in the country. It is by no means easy to criticise and appraise properly the science of a few centuries past. We have always a number of words ready which show our appreciation of what we do not always understand, such as ignorance, folly, superstition, rhapsody, worshipping of authorities, and many others; but these are quite as applicable to ourselves, and do not make us any wiser. To do the earlier epochs justice, however, we must divest ourselves of our present knowledge, and judge the old writers by what *they* knew, not by what *we* have come to know.

But whatever views were taken of the aim of science, whether the severely practical and utilitarian, or the purely scientific—that is to say, investigation expressly intended for ascertaining truth,—there can be no doubt about the widespread interest that was felt in the 16th and 17th, and even in earlier centuries, in such inquiries. That the views were to a very large extent practical was to be expected, for, after all, the struggle of mankind, individually and in society, is towards amelioration. It is natural,

indeed inevitable, that the first effort of man should be to ward off sickness and disease; and it is from medicine as a centre that most of the other sciences—those, at least, connected with natural history—have made their departure. The physicians have been the pioneers in zoology and botany, mineralogy and chemistry; and, as they supposed that things celestial ruled in things terrestrial, they were not unfrequently astrologers, mathematicians, astronomers. It is not surprising, therefore, that the oldest collections of natural history and of practical receipts are mainly for medical use, and that for them we are indebted to the compilers of various times. The writers of them were devourers of books, laborious extractors, copyists, systematisers. They recorded all that they found in the books they had read, independently of its worth or verity. They were neither critics of the old ideas nor originators of new. If the authorities they quoted differed in their views as to the virtues of a plant or mineral, or as to the treatment of a disease, they apparently did not think of reconciling the conflicting statements, or of showing the greater truth of one as against another. They had done *their* work when they assigned to each author his own opinion; and, like the modern editor, they did not hold themselves responsible for any opinions expressed in the different articles.

The model upon which some of these works is constructed, is simple, but efficient. The big book of Jacobus of Padua, for example, begins at the head, and describes all the known diseases of the body down to the toes, and under each gives the remedies —animal, vegetable, mineral—recommended for each by the different medical authorities down to his own time, the beginning of the 14th century. It is a vast repertory of *materia medica* and therapeutics, but, instead of being based on scientific systematic investigation, it is a collection of statements culled from Greek, Latin, Arabic, and subsequent writers. Precisely the same plan is followed in Varignana's *Secreta Medicinæ*, and the "*Kitchen Physician*" of 1680, was unable to arrange his subject in any better way; and, I regret to add, he had no improvement to exhibit, either in his mode of treatment or in his *materia medica*.

The medical secrets were accompanied by books on physiological secrets, and here, without question, the work ascribed to Albertus Magnus in the 13th century has the first place. It went through numerous editions in the 15th century; it went through a

multitude of editions in the 16th and 17th. It was translated into various languages, and printed in various countries. It was the popular guide-book for centuries to the physiological secrets which youthful and vulgar minds are so intent upon knowing. After having done duty in the original Latin for hundreds of years, it has drifted into the chap-book form, and has been taken under the patronage of the publishers of popular literature, but without Albertus' name. When one knows the views enunciated in this later form of the book, one recognises the source of a number of popular notions kept alive in a hidden way, by this constant republication of Albertus' treatise. It seems to be a sort of standard manual for all those to whom more accurate knowledge is inaccessible. Perhaps one result of the teaching of physiology in schools, and the introduction thereby of modern scientific literature, will be the stopping of the sale of this book, and thus ending the influence which Albertus Magnus has exercised for six hundred years over uneducated people. If so, it would be a curious finish to one of the most noteworthy books in European literature.

Medical secrets, however, did not constitute the whole scientific literature of the time. There were also numerous miscellaneous collections of technical receipts. For several centuries books of this kind, occupying different areas and of different sizes, issued from the press, showing how wide the demand for such technical knowledge must have been. I take it that people in the old times had to be much more self-reliant than we are. Labour could not have been so subdivided as it is now, but each family depended largely on itself for whatever practical work had to be done. When, for instance, people did their own dyeing and colouring, they must have been constrained to go to those with experience, or to receipt-books for direction as to the production of effects wanted. Consequently, we find both general collections of receipts for all sorts of purposes, as well as treatises which expound the secrets of one art alone.

Books on natural history—strictly so called—were much in request; but it was a narrative of the wonderful works of nature, the unusual phenomena, the catastrophic events, that was desired, and not a careful investigation of how the unobtrusive operations of nature are carried on. Hence the treatises bore on their title pages that they were concerned with prodigies and marvels, and secrets, and wonders of nature,

and they came from the printing-presses in large numbers and numerous editions. If time permitted, and this were an appropriate occasion, I could find you entertainment in the wonderful beliefs about natural history which passed current in Europe before the era of exact and critical observation. Even the older writers on botany, zoology, mineralogy, geology, astronomy, meteorology, who have a distinct title to be regarded as scientific naturalists, were unable to rid themselves of a bias towards the marvellous, the fanciful, and the speculative, even when dealing with matters that might have come under their own observation.

All these treatises, medical, physiological, technical and artistic, physical and mechanical, and so-called magical, and the histories of invention and discovery, to the tune of several hundred, as I have myself ascertained, ran their course, and supplied a want when there was no real scientific literature, and when practice must have been empirical. This literature flourished luxuriantly in the 16th century. In the 17th it was, perhaps, less in demand. Scientific observation, in the modern sense, was dawning, and the other necessarily began to fade. Speculations as to the nature of matter, more exact measurement, the recognition that material nature is not haphazard, but is under a wonderful system of laws which must be obeyed, began gradually to be recognised. Still, what a cloud of ignorance overshadowed men's minds a couple of centuries ago can be seen by a glance at the *Arcana Microcosmi* of Ross, or Glanville's *Scepsis Scientifica.*

The old natural history books and medicine receipt books died a natural death. People learned the new truer facts about nature, and the fancies that had come down from the ancients through the mediæval compilers were simply neglected. The publication of these books ceased.

Of all these different sets of books, the technical secrets have probably been the last to disappear. There are still methods in use in various arts and manufactures which are empirical, the result of individual experience, and care, and skill. Such secrets are jealously guarded even at the present day. To that one cannot altogether take exception. As long as science is incomplete, and the causes or at least the rationale of certain phenomena are unknown; as long as man is more eager to make use of the powers and resources of nature for his own immediate ends than to understand their laws, so long will there be empiricism in the arts and manufactures. The advocates of empiricism are

not without a word in defence of themselves, even from history. They can ask, "Have there been no lost arts?" Can we, with all our technical skill, coupled with our scientific knowledge, produce, say, the ruby glass of two centuries ago,—to go no further back? Could the ancients, the Egyptians for example, or earlier nations, if there were such, have accomplished what they did if they had not had some physical and chemical knowledge? If they had no science like ours, one is almost driven to saying that their empirical skill was, in certain ways, equal to our scientific and technical skill combined. Still, even supposing that be granted, it will not justify or help the manufacturer who argues that rule-of-thumb is sufficient for to-day. Rule-of-thumb is only a temporary make-shift till scientific skill and accuracy are available. No rule-of-thumb could have created electric lighting. The discovery of Prussian blue was the result of an accident, but there would never have followed the prussiate manufacture, there would never have been discovered that whole section of carbon chemistry which starts from cyanogen, if the fortuitous concourse of atoms that came together in the first blue precipitate had not been afterwards examined and sifted till it was no longer fortuitous, but was brought into order and under law, and made to appear when wanted, not by rule-of-thumb, but by the necessity of its being. It is this necessity which differentiates science from empiricism, and it is the difficulty of ascertaining it which leads not only to the neglect of it, but to the assertion of its disadvantageousness. But the man who asserts that, because the practical result is what concerns him most, he can ignore the scientific principles which are involved, that he can arrive at his result more quickly and effectively by haphazard trial and rule-of-thumb experience than by the application of the necessary laws which the phenomena obey, will find himself beaten sooner or later, not by his fellows, but by a much more formidable rival—by Nature herself. To pit empiricism against science displays a wilful ignorance of the whole development of science in every one of its departments. The whole effort of the human mind is to leave the ever-shifting phenomena, and to reach the firm ground of law and system. Technology — the whole circle of the so-called practical arts, medicine included—attains its perfection only as it becomes scientific.

Obviously the day of popular beliefs, as distinct from scientific truth, is over. These must now be based upon scientific teaching,

and the only difference that can be acknowledged is one, not of kind, but of degree. The general run of people may not know so much as specialists, but what they do know will be correct. Science teaching in schools and the necessity for some knowledge of science forming part of a liberal education, will complete the task of eliminating erroneous conceptions as to material nature, which has been in progress for the last two centuries.

Our Society has had a share in educating several generations to the importance and interest not only of scientific studies, but of the application of science for the improvement of the arts. It is our belief and hope that in this year, and in other years to come, the same steady progress will be made, and that the Society's influence will be still more powerfully felt.

PRESIDENT'S OPENING ADDRESS TO THE ARCHITECTURAL SECTION.

II.—*On Architecture as an Art.* By CAMPBELL DOUGLAS, *V.P.*,R.I.B.A.

[Read before the Section, 13th November, 1893.]

IT is now forty-five years since our Architectural Society or Association was formed, and almost twenty-three years since we were constituted as a Section of the Philosophical Society; and this is the fifth time that I have had the honour of appearing as your President to open our session. If, therefore, age has given us experience, something more than grey hairs should testify to the influence we have exerted on the community.

In considering how, with advantage to ourselves, I might occupy your attention for a short time to-night, it has occurred to me that I could not do better than to try to answer these two questions, namely:—*First.* For what purpose do we exist as an Architectural Section of a Philosophical Society? *Second.* How far is our existence justified by the result?

I. What is the object of our corporate existence? When I turn to our Articles of Association, I find the answer to this question there concisely and not inadequately stated, as being for the furtherance of the Art and Science of Architecture. It seems that now the first thing we have got to do is to settle in our minds what Architecture is; for, unless we clearly understand that, we may be simply wasting our energies in pursuing the shadow of an investigation. I take it that Architecture represents a complex entity. It is not merely, or by any means only, the art of designing and building on scientific principles, and of correct construction, for if that were all, Architecture might be merely the product of a builder and civil engineer—that is to say, of a man capable of designing buildings in which the result would be a convenient enough structure, without any waste of material, but which might be well nigh as ugly as conceivable.

I remember that when I left my father's manse, upwards of fifty years ago, to go to serve my apprenticeship with the late

Mr. Rochead of this city, an old and faithful servant of ours, who heard that I was being thus launched in the world, said, in her own fine native Doric, "What for are ye sen'in' the laddie awa' to be a stane mason?" I am not sure but that the surmise of my old nurse was a fair enough reflex of the ordinary or average view of the public, and that the number of those who have a much more exalted appreciation of what constitutes an architect is limited.

Some of you may have seen, or at least heard of, an interesting volume which was published fully a year ago, under the title, "Architecture: an Art or a Profession?" It consists of thirteen essays; and, while agreeing with much of what the essayists say, though not with everything, my sympathies, on the whole, go with them. The book, as I have stated, is a most interesting one, well worth the attention of all who wish to form a cultivated opinion on the subject, notwithstanding that it has been subjected to the clever, one-sided, and rather unjust criticisms of Lord Grimthorpe, long better known as Sir Edmund Beckett, Q.C. The subject matter of the book very fairly opens up the question of "What is Architecture?" and, inferentially, "Who deserve to be called Architects?"

I am aware that these essays are the direct outcome of the controversy which was evoked by the system of competitive examinations fostered by the Royal Institute of British Architects. Like most questions in this world, there is a good deal to be said on both sides; but, when the profession sees architects of the artistic standing and liberal education of such men as Norman Shaw, T. G. Jackson, Micklethwaite, Reginald Blomfield, G. F. Bodley, Basil Champneys, and others, expressing their views eloquently, and, on the whole, it must be admitted, forcibly, on what should be the qualifications of a true architect, then wise men will, perhaps, ponder the matter more deeply than they have hitherto done. They may, probably, come to the conclusion that, while some men may exalt art unduly, the more common evil is to find men, practising as architects, whose notions of what is art, or of what constitutes artistic excellence, are superficial. But, it will still be asked, "Are we getting nearer to an accurate and satisfying definition of the term Architecture?" I reply that many men of education have attempted its definition, but have not met with the absolute success which might be counted upon were it an answer to a question in physics. Doubtless, if we can advance

sufficiently far in saying what it is not, we may gradually get within its sacred precincts. It has been defined as the art of building with nobility and ornamentation. I think that this statement implies and infers the true ideal of good architecture. It must be intelligent, imaginative, and artistic, if it is to be an art at all, or what we usually call a "fine art"—although to call art "fine" appears to be misleading, for surely real art cannot exist without its being felt to be "fine."

What, then, is this mysterious quality which gives to work the dignity of being "art"? It is here that imaginative intelligence displays her genius, for without intelligence the result is merely mechanical, and without imagination there cannot be any individuality, and without individuality the work cannot be associated with the mind which originated and fashioned it.

An architectural work, then, if it is to be a work of art, must give manifest evidence that it is the result of sustained thought, in which the materials and their disposition in the resultant building show such a fitness or adaptation to the desired end as will rivet the attention and satisfy the critical faculty of the observer.

No example of what is simply perfect scientific construction, in which there shall be no waste of material, no undue crush or strain, where everything is perfect in its nature and use, as in that eighth wonder of the world, the Forth Bridge;—no such structure can ever be called a work of art in the sense we are discussing this evening. No doubt, when one stands below that amazing bridge, which spans an almost impassable chasm, when one gazes on its labyrinths of girders, stays, struts, and cantilevers, and on the enormous intermediate piers, one is impressed by it—one must be silent in wonder. But it is with a feeling of awe that we contemplate it, as a sensitive child would look up at a giant, and no sense of the beautiful would glide into our soul—no sense of lovely nobleness, to set one a-crooning a familiar melody, as one would do if standing before the Pantheon or Salisbury Cathedral.

If any of you are disposed to say that I am not placing a fair analogy before you, I admit that you may have some claim to do so; but it is only because I wish to show that the function of the civil engineer is essentially different from that of the architect, and so, by bringing into sharp contrast these wonderful structures, I wish to illustrate, even if it were with the exaggeration of

caricature, that there is a quality in the one for which you may vainly look in the other. Let me, in further illustration, refer you to a great work in London, not yet completed, in which civil engineering and architecture are combined, and the effect promises to be at least picturesque, which is one of the characteristics of Gothic. I refer to the new Tower Bridge.

There are many architectural buildings which offend one's sense of fitness, even when there appears to have been a sufficiently accurate calculation of the strengths of materials, such as we are well accustomed to in this Victorian age of exact science and shoddy art.

All architects who have had a good grounding in classical architecture know that one of the first principles of good design is that there should be a perfect and evidently just reciprocal distribution of weights and their absence—that there should be what is understood by the formula of "void above void and pier above pier." What, then, are we to say to such buildings, which, in the supposed exigencies of commerce and trade, violate these first principles in the most flagrant manner?—and even (when one knows that the use of iron now makes structures safe, without the large masses of stone which once used to be necessary) every means is taken to conceal from view the factors of strength, by concealing these pillars with mirrors of glass; and did you not know that there is an unseen power of resistance, you would view such buildings with horror. In the very nature of things there cannot be any truly noble architecture in buildings erected under such structural conditions.

The human body has always been recognised as the absolute perfection of the beautiful, in its curves, lines, proportion, and adaptation to its end. In one of the Psalms there occurs a fine archaic thought, where, of God, it is said "he taketh not pleasure in the legs of a man,"—those keepers of the house that tremble as old age drives his mines too near. If, then, the great Fashioner of our bodies has higher objects of admiration than those curiously wrought pillars that support them, what might an artist think were he to find the Apollo Belvidere or the Farnese Hercules supported by wooden crutches or thin iron shafts.

Let us try the majority of the architectural works of the present day, which are seen rising in our various towns, and examine their so-called ornamental features. But what is meant by "ornamental" features? They appear in some part of the structure which might

in a humbler guise have been pleasing to us, but upon which, for the delightsomeness of expressed beauty, we have spent some labour and loving care. Observe, then, that the features which you ornament be really parts of your building, and not excrescences, made up of parts which might, if one had a kind of planing machine or scythe, be entirely removed, and the intrinsic completeness of the building remain sound as before this operation, if, indeed, it be not sounder and more wholesome. For, pray, consider what is the value of such ornamental features, on which you have laid out 5 or 10 per cent. of the cost of building. They are, as a matter of beauty, of the same value as the jewel in the swine's snout, or rather less, for the jewel would be always worth something. And, to take an everyday instance, what of the ornament itself? Who ever really thought that to crown his chimneys with common moulded fireclay cans was an artistic finish? If not, how then can they be ornamental? Many other familiar but unnoticed instances of mistaken views as to what constitutes ornament might be given, such as the meaningless and generally very clumsy flat slabs, called pilasters and lintels, in low-priced marble mantelpieces—when the difference of cost of using a good stone might have been spent with some degree of taste. In another department, any one may observe the plaster cornices in one's own house, or in those of one's richer neighbours, filled in with one, two, or three "enrichments," according to the purse. These "enrichments," as they are called in the trade, are modelled, cast, and sold by the foot or mile, according to the demand. Can such give any lasting pleasure? The artistic modeller might certainly produce for you something you could take pleasure in; but, then, it could not be bought by the hundred. So is it with the sculptor or stone carver. Let us refer to the higher of the two—the sculptor. His figure must be living, like Pygmalion's statue, and should be so adapted to its place, that, were it not there, you feel there is a want—as in the home where the candle has been put out, which no "Promethean heat can again relume."

But it is not often we can have the "breathing stone," so we are fain to put up with modest carved work, and very good work it may be, if only we get soul in it, from a man who loves his work, and who has no fear of the wolf at the door. For how can a man do work of this nature, if the day be only one long grind, with no living wage at the end of it?

But see to it that, if your employers do not know what should be done, at least you do. If you call in a doctor you do not sit in judgment on his pills and draughts, but you swallow the one and drink the other in faith. There is a great responsibility laid on the doctor to see that he does not poison you; or, failing that, that he does not imperil your health. So is it with your ornament—let it be good; let it be the best you can produce; let it be intelligent, imaginative, and reverential. Let it have its source in nature, but not be a slavish copy, otherwise it is ten to one it will be a mere piece of mechanical copyism, without the soul and life of nature; and he who drinks at this spring, the source of all truth, can find such copyism only distasteful.

You see it must be the outcome of thought as well as love; and, suppose it were a representation of some bird, or beast, or flower, it must not be realistic but be idealised, else it would not be art. At the same time, your work must be so animated and informed that one shall instinctively feel that its inspiration could only be from a divine original.

But, further, in the just use of ornament another principle must be borne in mind—it must be used sparingly, with discretion and with discrimination. For, consider what is the meaning of ornament. Is it not to emphasise some part or parts of the whole, so that the whole, through these parts, may command your admiration and solace your sense of beauty? What becomes, then, of this charm if the whole be overladen with ornament, as if a man should put a ring on each finger? The mind would get bewildered, perhaps it would only be a lucky chance if your taste did not become degraded. Indeed, I do not think I could be accused of crude and harsh assertion, were I to say that the public taste has sadly deteriorated. For the public is like our patient, as it swallows whatever pill or draught is given, until it comes to like them; and, now, there is a good, steady demand for much that those who ought to be the teachers can only loathe.

II. Allow me, then, to conclude with a few remarks on the second head of the programme with which I set out—namely, "How far has our Architectural Section fulfilled what I take to be the chief end of its existence?"

I confess that I think it should have accomplished more than it has done in the past. If it be true that Architecture is the most comprehensive and all-embracing of the arts, that to which

sculpture, painting, and even music minister, we have here a field to work on which deserves our best energies, with a large share of our time and a great measure of sustained attention. In the exercise of our calling, we have to deal with those by whom we earn our bread. They are at once our employers, and too often our critics, and we cannot afford to be unworthy of their esteem and to alienate their regard. At the same time, we must all do what we can to present better and better work. It is unfair to expect that many of them can be learned in such a complex art; but, as their standard of taste rises, the demand for better and purer Architecture will grow, and our art will flourish the more. There are, I am glad to think, many signs of improvement in our country, and Glasgow will not, I am convinced, lag behind, although there may still be much to be desired. We must demonstrate that good Architecture is not more expensive than bad—nay, as I have tried to show, it would in many instances be cheaper. Good form, and pleasing lines, and elegant grouping, are not more beyond our reach than the reverse; and one does not pay more for a fine broad scheme of harmonious colouring than for what soon comes to offend the eye that formerly admired it.

From what I have been saying I trust that no one will imagine for a single moment that I underrate that which may seem to some to be "the weightier matters of the law," such as sound construction, ventilation, and—what has grown up within the past twenty-five years or so—the modern system of scientific sanitation. There is no fear now that this last-mentioned subject will ever again be neglected in this practical age, as, from having been unknown, it used to be. A large number of our members are, from the nature of their business, specially interested in such subjects, and will not suffer them to be lost sight of. The educated architect must study them, and see that their principles are adequately given effect to in his work. But there is a great danger that these intangible and subtle qualities concerning art, which elude the notice of so many, may get pushed aside, and be trodden down in the mire of our busy lives.

I have, therefore, thought it proper to present, with all due respect, that side of the picture which I have brought before you to-night. I am now old enough, and, I hope, wise enough, to recognise my own shortcomings, and I know I have been connected with some buildings which I could willingly see suffer from dynamite. Therefore, I claim no immunity from criticism, but I press

upon all my fellow-architects who have the higher interests of an artistic profession at heart to strengthen the hands of this section of the parent society. It is the only medium we have through which to give expression to our views in a way that may reach outsiders. Our architectural membership might be very largely increased, although there certainly are a vast number of objects which claim the leisure of our evenings. I would urge all architects who are members of our section to hearten us with their more frequent presence.

A more united influence would certainly produce greater results, and we and our employers would act and react on each other as well as on ourselves, and the time would be hastened when the qualities which have engaged our attention to-night would be more and more visible, and our city, in its public buildings and in its private residences, as well as in its streets, would show a great increase in the nobility and beauty of its Architecture.

In conclusion, I would say in the words of one—not an architect, however—to whom the domain of all art is much indebted, and from whom I have learned some of those things I have spoken of to-night, I mean the author of the "Earthly Paradise," who, when speaking of Architecture, says, "I believe the practice of this art to be one of the most important things which a man can turn his attention to, and the consideration of it to be worthy the attention of serious people, not for an hour, but for a good part of their lives."

III.—*Technical Education in Glasgow and the West of Scotland: a Retrospect and a Prospect.* By HENRY DYER, C.E., M.A., D.Sc., Life Governor of the Glasgow and West of Scotland Technical College, Member of the School Board of Glasgow, &c.

[Read before the Society, 15th November, 1893.]

ALMOST exactly ten years ago, I had the honour of reading a paper before this Society, on "Technical Education, with special reference to the requirements of Glasgow and the West of Scotland," and a special meeting was held for its discussion. The opinions expressed regarding the proposals which I made were, without exception, very favourable, but the speakers almost all seemed to think that they were too ideal, and not sufficiently within the range of practical efforts. One distinguished educationist, indeed, said that they might be carried into practical effect fifty years hence; but, in his opinion, what was wanted was a practical plan which might be carried out now. It was not the first time in my experience that I had been told that my schemes were Utopian, and I have heard the same opinion many times since; but I have always held that the really practical man was not he who followed an opportunist policy from day to day, but rather the man who had carefully thought out a complete scheme, which he steadily kept in view, and tried to mould events in the direction of the ideals which he had formed. It is long since I took to heart Ruskin's advice, "whenever you hear a man dissuading you from attempting to do well, on the ground that it is Utópian, beware of that man."

In every department of life or work, it is advisable to take stock of past experiences, to extract from them what useful lessons we can, to see how far we have progressed from a given date, and to indicate what steps are necessary for carrying out a complete plan. This is what I propose to do to-night. The past ten years have seen great changes and developments in almost every department of education, and it will be useful to see how far Glasgow and the West of Scotland have profited thereby.

I may recall the fact that, at the time my previous paper was read, many educational inquiries and discussions were being carried on. The Scottish Endowment Commissioners had very nearly completed their work of collecting evidence as to the state of the institutions which were suited for secondary and technical education, and were considering the schemes which were proposed for more efficiently utilising the resources at the disposal of the country. The Royal Commissioners on Technical Education were collecting information both in this country and on the Continent, and a University Bill was about to be introduced into Parliament. In short, all our educational institutions were being subjected to a rigorous investigation, not only with regard to their financial resources, but also their educational arrrangements.

The schemes of the Scotch Educational Endowment Commissioners have now been in operation for some years. The Report of the Royal Commissioners on Technical Education has been before the public for about the same time, and has formed the basis of many discussions and a considerable amount of legislation, and the most important Ordinances of the University Commissioners are now in force. We will note how far the action of each of these bodies has been utilised for carrying out the proposals which I made.

These proposals I summarised in the following recommendations :—

1. That a technical institute be founded which shall superintend all industrial education in Glasgow, and form a centre for that of the West of Scotland.

2. That it include representatives of institutions of every grade of education—from the university to the primary school,—so that a connected system may be arranged whereby students who distinguish themselves in the lower grades may have opportunities of proceeding to the higher.

3. That it take advantage of existing institutions which at present give technical education, supplementing them when they are deficient, and arranging their courses so that there may be no waste of teaching power.

4. That the higher or professional parts of industrial education be given either in the university or in institutes which have been recognised as giving instruction leading to its degrees.

5. That the curricula of the secondary schools be modified so that they afford more thorough instruction in physical science, and thus prepare students who intend to study the higher parts of the subjects.

6. That secondary technical schools be founded, which will afford an introduction to technical training to those who have not time for the higher courses.

7. That corresponding secondary technical instruction be given in evening classes to draughtsmen, foremen, and the higher class of workmen.

8. That elementary technical instruction be given in evening classes to workmen.

9. That, for the most part, the practical training for the different trades be given in the workshops or manufactories.

10. That for certain trades which admit of it (such as weaving, dyeing, &c.), this practical training be supplemented by instruction in special schools or classes.

11. That three grades of diplomas or certificates be awarded by the technical institute—the first for those who aim at being managers or directors, the second for draughtsmen and foremen, and the third for workmen.

12. While recognising the actual workshops or manufactories as the chief places for practical training, that the instruction in the schools of the various grades be made thorough by the institution of laboratories, museums, and small workshops, which will give the students opportunities of making themselves acquainted with things themselves, instead of simply listening to lectures about things.

Before considering how far those recommendations have been carried out, a few remarks of a general nature on the subject of education may be advisable. In my former paper, I defined technical education as an education suited to the careers of the persons who receive it, and I warned my audience against the mistake of supposing that merely cramming the students with facts, figures, or details, had necessarily anything of an educative nature. I pointed out that it was impossible to draw a line between technical and general or liberal education, and I regretted that so much prominence had been given to the former name. I tried to insist on the necessity for all education being liberal "in the sense of enlarging the powers of the students, although there was no reason why a great part of it should not be technical, or such as has a direct bearing on what is likely to be their chief business in after-life. This object was clearly kept in view when schools and universities were founded in the Middle Ages, when the subjects taught were either those directly required for the professions, or were necessary as a foundation on which professional training might be based. But while the world has been moving onwards since those early days, and knowledge has increased, and new professions and callings have arisen, the great schools and universities have continued to afford very nearly the same sort of education as was given when the Church, Law, and Medicine, were the only professions, and when there were no trades or other callings which demanded an intimate knowledge of the great world of nature around us."

I have frequently in recent years expressed the wish that the term "technical education" had never been invented, or that a legislative enactment could be devised which would for ever put it out of existence. The ideas of many who write and talk about it do not seem to rise above mere mechanical manipulation in workshops, or the collection of formal information on a variety of more or less useful subjects, but which would do little or nothing for the education of the scholars, and would only serve to sharpen the tools with which the ever-increasing competition of the world is carried on, and which has driven almost all the pleasure out of life.

I do not believe that strict attention to what is generally considered mere utility, or the wretched policy of making so much study the measure of so much profit in money, ever yet produced one really educated man. A man's usefulness depends much more on what he is, than on what he knows; and industry, courage, endurance, and integrity are much more valuable qualities than the ability to pass examinations in general or technical subjects. Technical training by itself may make useful appendages to machines, but it will never make leaders of men who are qualified by their trained intelligence and liberal education to organise and guide the great industrial undertakings of the world, not only through their technical, but also through their economic difficulties. It is quite evident that the problems of the future which will require the greatest amount of attention will be of an economic, and not simply of a mechanical, nature, and they will require for their solution men who have been educated in a most thorough manner, and fitted to understand all the factors of which they are composed.

Even from a practical point of view, it is evident that success in any trade or profession does not depend so much on the amount of information which has been crammed into the learners' heads as is often suppesed. It depends incomparably more upon their capacity for useful action than their acquirements in knowledge; and, therefore, in the education of the young, attention should be directed to the development of faculties and valuable qualities rather than to the acquisition of knowledge, which may be deferred to a more mature age. If we wish our country to retain its position among the foremost countries of the world, we must recognise that neither technical skill nor scientific knowledge will avail much unless they are combined with breadth of economic

and political vision, and with depth of social feeling on the part of the citizens. All experience and history show us that the spiritual is the parent and first cause of the practical, and that an ounce of manly pride and enthusiasm has always been worth a pound of technical skill. It is, therefore, evident that the internal culture of the individual is among the prime necessities of human wellbeing, and that exclusive importance should not be attached either to the ordering of outward circumstances or to training for practical work.

In speaking, therefore, of the advances in education which have taken place in Glasgow during the past ten years, I will not confine myself strictly to those departments which are usually called scientific or technical, but will also glance shortly at the more general subjects which help to make men and women better fitted for their duties in life.

The first event of importance which I will notice is the institution of the Glasgow and West of Scotland Technical College exactly three years after my paper was read. It was founded by an Order of the Queen in Council, dated 26th November, 1886, according to a scheme framed by the Commissioners appointed under the provisions of the Educational Endowments (Scotland) Act, 1882, whereby Anderson's College, the "Young" Chair of Technical Chemistry in connection with Anderson's College, the College of Science and Arts, Allan Glen's Institution, and the Atkinson Institution, were placed under the management of one governing body, elected by the above-mentioned institutions and by representative bodies in Glasgow.

As one of the Governors, and as Convener of the "Calendar" Committee, I have naturally been able to exercise very considerable influence in moulding the arrangements of that College in the direction indicated in my paper, and now very complete courses of instruction are given in all the departments I therein named. It is rather a curious fact in the history of education, that these courses are almost identical with those which I had previously arranged for the Imperial College of Engineering, Japan, and which now forms part of the Imperial University. My proposals, at first, met with considerable opposition from men whose names were well known in the educational world who said that it was a mistake to specialise in a college or university course of engineering, and that all the students should go through practically the same curriculum. When they said this they

forgot that modern engineering is not a single profession, but a group of allied professions, all, no doubt, having a common basis, but differing entirely in the nature of the preparation required for their special work. The subjects are almost of equal value, from an educational point of view, and it surely will be admitted that it is only reasonable that the students should be allowed to select those which are most useful in the departments of engineering which they have chosen, as it is quite impossible to do justice to the whole of them.

In the Glasgow and West of Scotland Technical College there are day courses in the departments of

1. Civil Engineering.	6. Chemical Engineering.
2. Mechanical Engineering.	7. Metallurgy.
3. Naval Architecture.	8. Mining Engineering.
4. Electrical Engineering.	9. Agriculture.
5. Architecture.	10. Mathematics and Physics.

11. Chemistry—

and evening courses in

1. Mathematics and Physics.	8. Mining.
2. Chemistry.	9. Metallurgy.
3. Mechanical Engineering.	10. Agriculture.
4. Naval Architecture.	11. Chemical Industries.
5. Electrical Engineering.	12. Textile Industries.
6. Architecture.	13. Art Industries.
7. Building Construction.	14. Commerce.

The day courses extend over three years, and are educationally on about the same plane as university or college classes. The subjects of the first year—namely, natural philosophy, chemistry, mathematics, and drawing, are common to all the courses, while those of the second and third years are arranged to suit the requirements of the different departments. The time occupied with the evening courses depends on the state of preparation of the students when they enter, and the number of evenings per week which they can attend; but there is no difficulty in completing them during an ordinary apprenticeship, if the students have had a fairly good general education in the day schools.

In my previous paper I stated that "At present Glasgow University has three chief grades of examinations, the first for degrees for those students who have attended its classes, or those of teachers recognised by it, and the second and third for the

senior and junior certificates for pupils of secondary schools which are not connected with the University, and a similar system is required for industrial subjects. The technical institute, assisted by representatives of the various branches of the engineering profession, and of the chief trades, should award diplomas of three classes;—the first to those who complete the course at the Technical College, would represent the professional class; the second to those who complete the secondary technical and the evening classes, who would generally be draughtsmen and foremen; and the third to those who took the junior and the special trade evening classes, who would generally be workmen. The examinations for these diplomas should not be competitive—that is to say, there should be no attempt to place the students in the different classes in the order of merit, the standard being fixed to represent the minimum which should be required of the various grades of the different subjects. We have quite enough of competitive examinations at present, and nothing should be done to increase the number; those who wish special honours have sufficient opportunities for distinguishing themselves. When candidates present themselves for their diplomas, advantage should be taken of any other examinations they may have passed—those, for example, of any University, the Science and Art Department, and the City and Guilds of London Institute—to relieve them from further examination in the same subjects."

These proposals have been practically carried out in the Technical College, in which there are three grades of study and examination. For the first there is awarded the junior certificate, which is within the reach of all apprentices; for the second the senior certificate, which should be taken by those who aim at being draughtsmen and foremen; while the course for the diploma is suited to the requirements of managers or owners of industrial establishments, or of teachers of science. While in the College there are no classes for languages or general subjects, a list is given in the "Calendar" of those classes which are available elsewhere, and the students are encouraged to attend some of these. For the diploma the candidates are required to pass in a modern language and a general subject, so that something is done to lead the students into other fields than those which are directly applied in their ordinary work.

In each of these three grades of study and examination a considerable number of students have completed the courses,

passed the examinations, and obtained the certificates or diplomas, so that the arrangements are not simply on paper, but are actually being carried out in practice; and many of the students have shown in other examinations, independent of the College, that they have profited by the instruction which they have received.

The methods of examination for the diploma differ from those usually followed. No candidate is admitted to the examinations who has not attended and performed the work of the classes in a satisfactory manner, so that proper attention is ensured during the whole course. There is an examination of a comparatively simple nature in the subjects of the first year, to ensure that the students who proceed to the special courses of the second and third years are fairly well prepared, but the chief examination takes place at the end of the third year in the main subject selected by the candidate. The examination is partly by written papers and partly oral, and is of such a nature that it not only tests the candidate's knowledge of the main subject, but also of the various subsidiary subjects included in the course; and, when the subjects admit of it, laboratory, drawing office, or field work, forms an essential part of the examination, thus preventing anything like cramming.

The courses in the College having been fairly well organised, the next thing was to arrange that those students who wished to proceed to a university degree should be able to do so, and, at the same time, take advantage of the College work. A few years ago, I proposed to the Governors of the College that they should approach the Senate of Glasgow University and try to arrange that those students who had obtained the diploma of the College should be allowed to enter for the examinations for the degree of B.Sc., after a further attendance of one year, or of three full courses, at the University. After some negotiation, the Senate agreed to the proposal. As, however, the arrangements for graduation were being considered by the University Commissioners, I was deputed by the Governors to state the case for the College to the Commissioners, with the result that they confirmed the arrangement, and the Ordinance which embodies it comes into force from the beginning of the present session.

This, I consider, one of the most important steps ever taken in connection with a Scotch university, for it constitutes the three thousand students of the Technical College, potential graduates of the University. It was thus a large measure of university

extension, and may lead ultimately to a new ideal of university education, in which there will be a union of culture and manual work, and when men and women will pursue their studies from their love of them, and not simply for the purpose of "getting on;" and when they will apply their knowledge for the purpose of ennobling and improving their work, and not, as is too often the case at present, in order that they may be able to dispense with all useful work. The ideals of the founder of the "Andersonian" may thus be reached, although by a different method than that which he anticipated, and the University, Anderson's College, the Mechanics' Institution, the School Board, and other teaching bodies will form essentially one organisation, in which the educational requirements of all classes of the community will be fully met, in so far, at least, as scientific subjects are concerned.

In connection with the Technical College there is Allan Glen's School, which has, since the institution of the College, been considerably developed in its arrangements and extended in its buildings. The elementary department has been very much reduced, and the School is now chiefly a secondary school, which has been organised specially with reference to the training of boys intended for industrial and mercantile pursuits; and the scholars receive a careful, progressive, and extensive training in science, in art, and in workshop exercises. At the same time, due regard is paid to the requirements of a sound general education, so that the pupils may be able, at the age of 16 or 17, to proceed with profit to College, or enter practical life, possessing well-developed faculties and useful attainments.

The following statistics, showing the occupations of the students attending the evening classes of the College during Session 1892-93, and the number of students attending the College and Allan Glen's School, will be interesting, and will give some idea of the extent of the work, and the occupations of those who chiefly take advantage of it:—

I.—MALES.

Mechanical Engineers, ...	826
Draughtsmen, ...	153
Civil and Mining Engineers, ...	103
Clerks, ...	302
Teachers, ...	118
Architects and Measurers, ...	62
Carry forward, ...	1,564

MALES (*Continued*).

Brought forward, ...	1,564
Plumbers, ...	152
Painters, ...	83
Joiners, ...	62
Masons and Bricklayers, ...	21
Sanitary Inspectors, ...	9
Chemists, ...	96
Dyers, Bleachers, &c., ...	15
Electrical Engineers, &c., ...	85
G.P.O. and Telephone Co.'s Employés, ...	22
Brassfounders, Finishers, and Moulders, ...	26
Blacksmiths, ...	6
Ironmoulders, ...	8
Tin and Copper Smiths, ...	8
Platers and Ship Wrights, ...	7
Colliery Managers and Miners,...	23
Compositors, Lithographers, &c., ...	22
Farmers, Foresters, Gardeners, &c., ...	48
Warehousemen and Salesmen, ...	82
Managers (various), ...	7
No occupation, or occupation not stated, ...	133
Miscellaneous, ...	109
	2,588

II.—FEMALES.

Teachers, ...	37
Clerks, ...	8
Machinists, Tailoresses, &c., ...	6
Nurses, ...	2
No occupation, and occupation not stated, ...	38
Miscellaneous, ...	6
	97

Total number of students in Evening Classes, ...	2,685
,, ,, Day Classes, ...	233
,, ,, Allan Glen's School, ...	772
Total, ...	3,680

The small number of females who attend these classes arises, in my opinion, from the fact that no special arrangements have been made to meet their convenience, and, in the present over-crowded state of the most of the class-rooms, it is neither possible nor desirable to have a large increase in the number of female

students. The University has recently instituted a Women's Department, in which already very complete arrangements have been made, especially in the subjects connected with science and medicine, and it is to be hoped that the Governors of the Technical College will, before long, be able to have a women's department of the College, so that every facility may be offered for training in those subjects which are of use in the industrial occupations most suitable for women.

When I read my paper ten years ago, Dr. Henry Muirhead was President of this Society. It was the occasion of my making his acquaintance, and which led to many discussions with him on educational and social subjects. No doubt it also led to my being named in his will as one of his trustees for carrying out a scheme for the higher education of women, and to which he devoted nearly the whole of his wealth a scheme to which he had looked forward for a great part of his life. The rapid changes which have recently taken place in educational arrangements in Glasgow have prevented the trustees from beginning operations, but it is hoped that before long something definite will be decided on and carried out.

The work of the School of Art and Haldane Academy has steadily progressed during the past ten years, although it has been much hampered by insufficient accommodation and means. There is now, however, a prospect of these difficulties being overcome, and a wide extension of the usefulness of the school thus being made possible.

The Technical College has recently instituted a Department of Industrial Art, in which it is intended to teach the applications of art to architectural students, and to those engaged in the more artistic trades. These classes will do for art what the other classes do for science, and, like them, they should be made essential parts of the training of all apprentices, whose workshop experience is now generally very far from what it ought to be. It is still premature to say much about the success of these classes, but it will be evident that that must depend in great part on the manner in which they are supported by the employers and the workers.

The evening classes under the School Board of Glasgow have made great progress during the past ten years, and now form a very important part of the educational organisation of the city, there being nearly 10,000 scholars in all the departments. The

School Board has always paid great attention to the development of these classes, and much is due to the personal efforts of my predecessors in the office of Convener of the Committee in charge of them, and especially to Messrs. Fleming and Kerr.

During the past few years, however, a more definite attempt has been made at organisation, and the new code which was recently issued gives great freedom both to managers and teachers. It is now possible to arrange a continuous course of study from the ordinary classes to those of the Science and Art Department or other advanced subjects, so that as good an education may be obtained in the evening classes as in the day schools, although the latter will generally be more specialised than the former. In each district of the city it is now possible to follow fairly complete courses of instruction in the subjects required in the chief industries and in commerce, and these form stepping stones to the higher departments of the Technical College and the University. A few weeks ago the President of the Glasgow Branch of the Educational Institute, in an address, said that "the Institute's ideal of our country's education would be attained only when it would be possible for any child of ability to pass without a break from the alphabet class onward to the University, and any obstacles in his way must be removed." If he had examined the conditions in Glasgow, and especially the arrangements which have recently been made, he would have found that that ideal has been practically attained. Education is now free, for all who require help, to the door of the University, and there is a considerable number of bursaries and scholarships in the University, so that there is little difficulty for students with the necessary energy, perseverance, and ability, reaching the highest classes. Very likely it would be found that the overcoming of whatever difficulty still remains was the most useful part of their education, and would fit them the better to take advantage of the opportunities which were offered them to qualify themselves to undertake the higher departments of scientific and industrial work, and thus to enable them to render their best services to science and to the community.

In writing of secondary education, Mr. Acland, who is now Vice-President of the Committee of Council on Education, has said* :—"When Local Authorities take the whole matter of secondary school organisation in hand, they will have to deal boldly with the question of school curriculum. The report of the Schools

* "Studies in Secondary Education," p. 308.

Inquiry Commission makes us realise how far the choice of school subjects of study is determined by the requirements of the higher institutions, which form the natural outlet for the best of the pupils. Now the higher institutions to which the new schools will point will not, as a general rule, be the old universities, but the higher provincial colleges and technical schools. The mediæval requirements of Oxford or Cambridge, which, however stimulating to the great schools of the leisured class, have often been so baneful to the rural grammar schools, must not be allowed to blight the future of the new public secondary schools of the country. These schools will not be technical schools, but neither will they be merely literary academies. We must meet the wants of the epoch by the frank adoption of modern methods, and by the careful study, though by no means servile imitation, of the best work which is being done in those countries, which, in method and organisation, are so far in advance of Great Britain."

In a number of the day schools under the Glasgow Board considerable attention is now being paid to elementary science, and thus the foundations are being laid for the more advanced and technical parts of the subjects to be studied in central schools, the evening classes, the Technical College, or the University. A special committee, of which I am convener, is now arranging the curricula for the central or secondary schools which are about to be instituted or at least reorganised. These schools, while laying a good foundation in the way of a sound general education, will, towards the last year or two of the courses, cause special attention to be paid to those departments which are directly of use in the work which the scholars are likely to follow in their daily life. Those who are unable to complete the course in the day schools will have opportunities for doing so in the evening schools, so that the aim will be to make all the education which is given under the Board of a secondary nature, and thus fitted to enable the scholars, not only to perform their work more efficiently, but also to take a fair share of their duties as citizens, and to add to their own welfare and happiness. In my former paper I recommended "That the curricula of the secondary schools be modified so that they afford more thorough instruction in physical science, and thus prepare students who intend to study the higher parts of the subjects," and "That secondary technical schools be founded which will afford an introduction to technical training to those who have not time for the higher courses." If our ordinary secondary

schools were developed in the direction which I have indicated, they would, with the addition of special evening classes, meet all the wants of the greater part of the industrial community, although in some districts a scientific or technical school of a secondary nature, such as, for instance, that which has been instituted at Coatbridge, would be a most useful addition to the educational organisation.

There are various institutions of a semi-private nature which have been doing very good work in the development of education, and notably the Glasgow Athenæum, which now affords very complete arrangements for instruction in languages and literature, commerce, science, art, and music, and which, moreover, offers many of the advantages of a club, and thus gives opportunities for social enjoyment which are awanting in the more formal educational institutions. It thus fulfils a very useful function. The various Young Men's Christian Associations, and similar institutions, have also educational classes, which they combine with their primary objects, and, no doubt, do some useful service in this respect. It is, however, to be questioned whether such a combination leads to the highest educational efficiency. Probably better results would be obtained if these institutions endeavoured to supplement the work of the schools, and did not attempt to duplicate some of the classes as they do at present. These cannot be very efficient from an educational point of view, and they conceal how much or how little is being done to promote the main objects of the associations.

In the West of Scotland generally, while much has been done in the way of carrying on separate classes in science and art, little progress has been made in organisation. The only attempt at a science school out of Glasgow is that at Coatbridge, which has been instituted by the Old Monkland School Board, and which serves a very important purpose in the locality in which it is situated. In various parts of Lanarkshire, Renfrewshire, and Ayrshire, classes are to be found in a great many subjects, conducted either by School Boards or County Councils, or by private associations of various kinds; but it is very much to be doubted if the results obtained, from an educational point of view, are at all in proportion to the money spent or the energy exerted; and a great deal has yet to be done, not only in the way of development, but also of co-ordination of the various parts with each other, so that there may be economy in the money spent, and efficiency in

the results obtained. This, in fact, is the most important piece of work which must be faced during the next ten years. The present is therefore a very critical time in the history of education in the West of Scotland, and all the problems connected therewith should be carefully studied by those in charge of the educational arrangements of the district. These problems will not be solved by cheap and easy methods, but by systematic instruction suited to the different requirements and attainments of the scholars, and by a judicious combination of the resources at the disposal of the various local authorities. A few weeks ago, Mr. Buckmaster, of the Science and Art Department, addressing a meeting in Lanarkshire, said—"County Councils are sometimes endeavouring to find a short, easy road to knowledge, by means of itinerant teachers, demonstrations, and lectures. There is no such road; it leads nowhere. Systematic class-teaching is the only road. The money at the disposal of County Councils, if wisely administered, will give a new life and dignity to agricultural pursuits." A good general educational organisation is, therefore, the first necessity for success in technical education.

While very much could be done by the co-operation of local authorities to bring about a proper organisation of scientific and technical education, still I am of opinion that something else is required before we can have a system that is at once really national, economical, and efficient. The National Association for the Promotion of Secondary and Technical Education has asked that a Royal Commission be appointed to investigate the whole subject, and its demand has been repeated by the late Conference on Secondary Education at Oxford. I hope that the demand will be granted, and that Scotland will be duly represented on the Commission.

The sooner this is done the better, for, if delay occurs, vested interests, both personal and institutional, will be created, which will indefinitely hinder the carrying out of a complete scheme. A few weeks ago, Lord Elgin, who was a member of the Scotch Endowment Commission, and Chairman of the Special Committee appointed last year by the Government to consider the subject of secondary education in Scotland, in urging such a step as I have indicated said—"At this moment there are no vested interests created, and, you will believe me, from experience I can say that there is no greater bar to reform than vested interests. I am not speaking of personal vested interests so much, because I

think every fair-minded man will say that any personal interest must be dealt with fairly and liberally, but any institution that is practically a vested interest is difficult to move out of the way when reform is needed. I have known many cases of endowment in which, for many years, a half or three-fourths, or even the whole of the endowment was practically locked up in order to dispose of a system which was impossible to work with any advantage at the time at which it was dealt with." At the present time much money is being frittered away all over the country with very small educational results, and many interests are being created which, if they are allowed to take a firm hold, will resist to the utmost any change which interferes with them, and thus prevent the higher education being dealt with in a comprehensive, thorough, and truly national manner.

A Commission is wanted, not only for the purpose of co-ordinating the educational agencies of the country, and thus utilising the means at our disposal to the greatest advantage, but also for bringing our educational legislation into something like order. During the past few years especially this has been conducted in a most haphazard manner. The Educational Endowment Commissioners had scarcely completed their labours when Parliament passed a Technical Education Act, which took no account of what had been done by the Commissioners, or was being done by School Boards, to meet the demand for technical education, and yet the Scotch Education Department is still wondering why that Act has been practically a dead letter. A few years later Parliament practically abolished fees, which still further changed the conditions under which the Commissioners had made their arrangements. A scheme to compensate publicans having fallen through, part of the money set aside for the purpose was used for the further relief of fees, and another part handed over to local authorities with power to use it for the development of technical education. Lastly, when England received the privilege of free education, an equivalent grant was made to Scotland, a portion of which has been set aside for the purpose of encouraging secondary and university education. The future historian of education will find in the work of the past few years very good examples of our "practical" methods of legislation.

In the last Report of the Science and Art Department there is a sentence to the following effect:—"Without a sound foundation of general education the highest scientific training

cannot be imparted; without a sufficient supply of teachers with adequate salaries, who are not over-worked, and who not merely know their subject, but know how to teach it, a considerable part of the money expended on the encouragement of new forms of education must be wasted." These words may sound as truisms, but, unfortunately, what seem to be self-evident truths are very often neglected by those who are responsible for educational arrangements. This is especially true of those connected with scientific and technical education, and a compendium of facts, which can be given in a few lectures, is put forward as sufficient for the industrial salvation of the country. There can be no greater fallacy. Unless the training is of a real educational nature, and be imparted by men who know how to teach, it may do harm rather than good, by forcing the minds of the students into grooves from which they cannot escape, and thus lead neither to the intellectual, moral, nor industrial development of the country.

It must, moreover, be understood that a knowledge of elementary science, and a certain amount of technical skill, while useful for improving the intelligence of individual workers will, in themselves, have little effect on the great industries of the world. The men who will revolutionise old industries, or create new ones, will, as a rule, be men who have thoroughly studied the theory of their work, and made themselves acquainted with the best practice. Hence the necessity for making arrangements for enabling those who are specially qualified by nature for such work to reach a position by which they will be able to render their best services to the community. Arrangements of this kind are, as I have pointed out, now gradually being carried out, and scholars can pass, without much difficulty, from the lowest classes of an elementary school to the highest classes of a university.

In my previous paper I pointed out that "All educational science and history teach us that educational improvement works from the top downwards, and not from the bottom upwards. If the professional schools, let them be called universities or technical high schools, represent a low standard of instruction or examination, or an incomplete curriculum, the primary and secondary schools leading up to these institutions will always be feeble and inefficient. In considering, therefore, the scheme of education for training men for any profession whatever, the first

thing we have to do is to find out what is necessary for those who occupy the highest positions, and make that the standard to which all arrangements lead. I have no doubt some persons will say that this is beginning at the wrong end, but I would advise such to study history, and they will alter their opinion. After the crushing defeat of Jena, the Prussian Government undertook the regeneration of the state through education, and the first thing that was done was the establishment of the great Frederick William University at Berlin; and such was the effect, not only in the schools, but also on the other universities, which had fallen to a low standard, that Germany now leads the world in intellectual progress; and we all know how great an influence the universities of Britain have exercised on the schools which lead up to them."

Both from an educational and a practical point of view, it is necessary, therefore, if scientific and technical education in the West of Scotland is to rise to the proper standard, that Glasgow University and the Technical College should afford all the opportunities for obtaining the highest training in science and its applications. The connection which has been made between the University and the College will be of the greatest advantage to the students, for the education which is given in the one is, to a large extent, supplementary to that given in the other, and it will thus be possible to obtain a more complete education than would be the case in either alone. The course in the Technical College should be more special and technical than that in the University, whose function is to give more theoretical and general instruction.

Time will not allow me to enter into the details of the methods to be adopted or the subjects to be taught in the higher scientific departments, and I must refer to some of the papers which I have published on these matters, and especially to two which have appeared in the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, on "The Education of Engineers,"* and "A University Faculty of Engineering."† Those, however, who are concerned with the management of universities and colleges should keep themselves acquainted with all the most recent developments in different parts of the world, and adapt them to the requirements of the institutions under their charge.

In my previous paper, I said—"I have no doubt that fifty years

*Vol. 30, p. 127. †Vol. 33, p. 15.

from this the buildings devoted to technical education in Glasgow will rival the handsome pile on Gilmorehill, and, while recognising the advisability of obtaining as suitable buildings as possible, in the meantime let us follow the example of the early universities, and first create a demand for the newer education before we invest money in stone and lime, which could be used to greater advantage in providing good teaching and apparatus. A college, or university, is not necessarily all contained within one building, but for success it is requisite that its various parts be so arranged that they all work in harmony. For instance, in the German universities you often find the most important subjects taught in what are called institutes, all of which, however, take part in the university programme of teaching."

The advice I gave has been followed out, and the existing buildings have been utilised to the fullest extent, very much on the lines which I indicated, and now they are overcrowded. Moreover, many of them are unsuited to the purposes for which they are intended, and quite behind the requirements of the age. While it may not be advisable to spend a very large amount of money on buildings, still it must be evident that one of the most pressing wants of scientific education in Glasgow is more adequate buildings for the Technical College; and this is one of the first things which should receive attention from the whole body of citizens. There is no other city in Britain doing so much work in connection with scientific and technical education as Glasgow, in which the appliances are so thoroughly inadequate.

I have several times expressed the hope that we would have new buildings before 1895, which will be the centenary of the Anderson's College, which now forms part of the Technical College. The time is now short, but it is still sufficient to, at least, make a good start. It would be out of place if I dwelt in detail on the sources from which the money required ought to be obtained for the purpose; but I hope the Governors will at once take up the matter with vigour, and I am certain that if they place a well-considered scheme before the citizens of Glasgow they will not be disappointed. No doubt private liberality or benefactions will do much; but it may be pointed out that the Town Council has under its control a considerable amount of money, under the provisions of the Local Taxation Act, which may be used for the purposes of technical education; in England it has been so used to a very large extent, and it will never do for Glasgow to

fall behind in the provisions for the training in trade and industry, which is so essential to its prosperity.

It is not necessary to enter into a detailed description of what the new buildings ought to be, as a very fair idea can be formed by those interested in the subject by a visit to any of the modern institutions in this country or on the continent. Special reference may be made to the Zurich Polytechnic, as an example of what should be done to encourage higher technical education. Even as an investment the Swiss think that their money has been well spent. Some of the recent American and Canadian institutions are also very well worthy of careful study.

The arrangements which have been made for the educational organisation of the Glasgow Technical College will for many years be sufficient to meet all requirements, if more complete appliances be provided and special teachers appointed as the demand arises for instruction in special departments of industry. In the future, however, greater attention must be paid to the quality of students than to their numbers, as the work of a college should be confined to the higher branches of the subjects, while the more elementary should be taken up in the schools.

The evening classes should always form a very important part of the work of the College, for they allow a combination of study and practical work which is certain to lead to better results, both educationally and industrially, than if the students were kept at college for a long period before they had any practical experience. While the day classes in the more general subjects are likely to be much used for purposes of general culture, the more special and advanced classes will, as a rule, be of most use to those who have passed through the evening classes, and who have also had some experience in workshops and manufactories.

I have mentioned the large measure of what is practically university extension, which has taken place by the connection which has been formed between the University and the Technical College. In order, however, that the educational arrangements necessary, not only for those engaged in industry, but also of many others, may be complete, another step requires to be taken, whereby the subjects useful for general culture may be brought within the reach of all. Professor Jebb, M.P., in a recent letter to the *Times*, said that "a small outlay would greatly enhance, in the long run, the value of the return which the country gets for the three millions a-year which it spends on elementary education.

Moreover, there is another aspect of the matter which should not be overlooked, and that is the bearing of university extension on the future of secondary education. If, as seems probable, secondary education is to be developed on popular lines, there will, by-and-by, be large numbers of young people who, after receiving their secondary education, will wish for something higher, but will not be able to go to any English university or to a university college. Popular secondary education will need university extension as its complement. This is one reason the more for desiring that the extension system should be placed on a more secure and permanent footing. The value of its machinery has already been officially acknowledged in the use made of it by the county councils. Its friends now plead that the work which has been done, and is doing, for national education may be recognised by the state." A few years ago, when the university extension movement was started, I pointed out that, in order that it might be successful, it was essential that it should be made an integral part of the university system, and that the work done should qualify to a certain extent for degrees. While it is not desirable to make degrees the main objects of any educational work, there can be no doubt that when that work has been so arranged as to lead through definite courses of study, the results are more satisfactory from every point of view than when it is carried on in a haphazard manner. It would be a comparatively simple matter to draw out courses in different departments in connection with the university extension scheme, which might be allowed to qualify for at least one half of a degree course, leaving the other half to be taken in the ordinary university classes. Moreover, a comparatively small number of students in each centre, who had determined to go through their work in a thorough manner, would have a great effect in attracting others for special subjects, and thus, as the movement spread, we would have, what is very much wanted, a combination of practical with intellectual work. If the university courts have not powers to carry out such an arrangement as I have indicated, then the University Commissioners should at once be asked to consider the matter, and to issue an ordinance which would bring the universities within the reach of all classes of the community, and enable them to include within their organisation all the higher education in the districts in which they are situated. The University Commissioners have done much to bring the universities into touch with the requirements of the times and

to extend their spheres of influence, but there is still room for a great development before the ideal modern university is reached, which will profoundly affect the national life in all its intellectual, moral, and social interests. The greatest difficulties of the present day, and the greatest dangers of the future, will arise, not so much from want of technical skill, as from the want of a clear realisation on the part of employers and employed of the conditions of economic and social welfare, and the university extension scheme might be usefully employed in giving facilities for the study of the economic and social aspects of the subjects.

The applications of art to industries must receive more attention in the future than they have had in the past, and the teaching made more suitable to the requirements of the work. For many years past bald utilitarianism and cheap sham have been the chief characteristics of what ought to be art industries. If our schools of art and technical colleges were properly organised, we would gradually come back to the old ideal, when the craftsman was artist and workman, and when art was used to beautify the most common objects of every-day life, or to ennoble the civic possessions of the people, and not as a thing to gratify the vulgar vanity of rich men. In my opinion, in order that instruction in art applied to industries may be duly co-ordinated in Glasgow, it is highly desirable that the Technical College and the School of Art should be placed under the same management. It is impossible to draw a line of demarcation between the functions of the two, and no technical college can be considered complete which does not include art and its applications to industry in its programme. This arrangement, however, need not mean a highly centralised system of management. The work of the different departments should be placed under the control of committees who are specially interested in them, the whole, however, being subject to the general control of the Governors. Every art industry might in this way receive its due share of attention.

Even in one building a high degree of concentration of classes is not desirable. The more special departments should be situated in the districts in which they are most required, and, to a large extent should be managed by those directly interested in them.

In my former paper I stated that "the whole programme of the City and Guilds of London Institute might be fully represented in Glasgow, not necessarily by special schools, but by classes in schools, which also afforded the students opportunities

for instruction in general subjects. We have one special or trade school in Glasgow, the Weaving School, which has been very successful so far as its means would admit. Establishments of this type are of the utmost importance to the industries which they represent, and are not to be looked upon as apprenticeship schools, for they cannot supply the need of actual experience in the manufactory, but only afford instruction which enables the pupils to take advantage of what is to be learned there. They ought, however, not to be so isolated as the Weaving School is at present, but should be connected with institutions which give instruction in drawing and designing, the elements of mechanics, and some branches of general culture."

The position of the Weaving School is practically the same now as it was ten years ago. That is to say, it is an institution by itself, with no connection with others of an allied nature. It is only a single unit of a large scheme which was never carried out, and those who were most actively interested in its foundation looked forward to it becoming a part of the Glasgow and West of Scotland Technical College, which was organised later. They, in fact, arranged for the insertion of a clause in the scheme of the College which would allow for amalgamation with the Weaving School. The difficulties in carrying out the arrangement have been chiefly of a financial nature, but funds are now being made available, which should enable these to be overcome, and, at the same time, allow more complete arrangements to be made for instruction in various subjects more or less directly connected with weaving.

The evening classes of the School Board are being gradually organised, and now, as I have stated, in each district of the city fairly complete courses of instruction are obtainable, not only in the ordinary subjects of a general education, but also in the special subjects required in industry and commerce. As these are still further developed, the scholars in different parts of the city will find arrangements for a good preliminary training within a short distance of their homes, and the special classes can be co-ordinated with those of the Technical College, so that there may be a continuous course for those who wish to study the higher and special subjects.

A large number of the subjects of the programme of the City and Guilds of London Institute are now taught in Glasgow in connection with the Technical College and other organisations,

although the stoppage of the grants by the Institute has recently had a damping effect upon them. Part of the money at the disposal of the Town Council for purposes of education should, however, be used for the support of these classes, and both the employers and the workers should take an interest in them. One of the most successful classes in the Technical College is that for plumbing, and it illustrates the good results of such a system of co-operation. Those engaged in the trade feel that, in a sense, the class belongs to them, and they take a pride in it, and use their influence to get apprentices to attend.

The question of apprenticeship is so closely bound up with technical education that it is advisable to make a few remarks regarding it. There can be no doubt that, if employers took a little more interest in the training of apprentices than they do, the whole question of industrial education would soon be solved. The workshop training now-a-days is so specialised that good all-round workmen are difficult to find. Arrangements are, therefore, required to supplement the experience gained in the workshops. We are not yet ripe for the attempt to carry out Ruskin's ideal of having national workshops attached to our schools for the training of apprentices, although it must be admitted that we are moving in that direction.

In my opinion, all employers should insist—as some, indeed, do at present—on all their apprentices attending evening classes for two or three evenings a-week, and, in fact, making the classes essential parts of the apprenticeship. To encourage those who do well in them, or who have had superior educational advantages, there should be some allowance made for difference in attainments. If five years be considered the normal length of the apprenticeship, and if all who expected to rank as journeymen were required to hold the junior certificate of the College or its equivalent, those who had obtained the senior certificate might be allowed to get off with four years, while those who hold the diploma should only be expected to serve three. It is very discouraging to the boys to find that those who have done well in their studies should be required to serve exactly the same time as those who have almost, if not entirely, neglected them. Of course, I recognise the financial element in the problem; but surely it is about time that we attended to the proper training of our youths, and did not use them simply on account of their cheap labour. If it were made a condition in the employment of all apprentices, there would be no

hardship to individual employers, as the same would be expected from all. Unless something be done in this direction, Ruskin's ideal will become a reality much sooner than is at present expected.

It must be clearly recognised that the mere organisation of educational institutions is not sufficient to make technical and scientific education a real success. It must be supported by the action of the employers of labour, and by the force of public opinion. If the employers had a real appreciation of the need of improved education, and if the public, instead of hunting after cheap bargains, encouraged the production of good work, the schools and colleges would be in little danger of want of support. This is especially true of those connected with art. We may rest assured that so long as the public are content with cheap imitations, so long will speculators meet their demand, and real craftsmanship will be impossible.

One of the most important branches of technical education is that which fits for commercial work, for without it a great part of the advantages gained by higher technical skill in art and industry may be lost. On the Continent it is usual to have special institutions for commercial training; but, in this department as well as in the more strictly technical, it is better to follow the British custom of giving preference to the practical side of the work, and here, again, the evening classes will perform a most useful function.

If the scholars have obtained a good general education in a secondary school, in which special attention was paid to modern languages and the other subjects of importance in commercial pursuits, the majority of them could easily obtain all they required in addition in properly-organised evening classes. These, in combination with the practical training which was obtained in the counting-house or manufactory, would afford a more generally useful introduction to mercantile work than could possibly be given in any special institution which had no connection with practical business. If merchants and others insisted on all those who entered their offices having the leaving certificate of a good secondary school, and if, during their apprenticeship, they further insisted upon their attendance on a certain number of evening classes and obtaining a higher commercial certificate, the problem of commercial education could be easily solved.

The colleges and universities, however, might supplement the work of the evening classes. There are many subjects taught in these institutions which might be of great service to those engaged

in commerce or industry, and there are no reasons why a class should not be taken each year, after the young men have commenced business, or, at any rate, after they have completed the course of the evening classes. Moreover, this combination of study and work would not only be a good thing in itself, but would also add to the enjoyment of those who took part in it, by making their lives fuller in the true sense of that term.

The arrangements, of which I have given an outline, would be sufficient to meet the requirements of Glasgow and the immediate neighbourhood, but the Technical College is meant not simply for Glasgow, but for the West of Scotland generally, and it should become for that district what I pointed out the *Ecole Centrale* in Paris had become for France. The freedom of arrangement or of methods in the different localities should not be interfered with, but, at the same time, the object of all concerned in the management should be to make the most of the educational resources at their disposal. These resources do not belong to them as individuals, and should, therefore, not be used chiefly for the purpose of magnifying that part of the work in which they happen to be most closely connected, but in rendering to the public the greatest possible service.

This should be especially kept in mind at the present time, when the educational arrangements of the country are in a rapid state of change, and when School Boards, Town and County Councils, and Burgh and County Committees, are all spending money on secondary and technical education, and between which it is neither possible nor desirable to draw a strict line of division. If these bodies co-ordinate their efforts, and unite their resources, they will be able to contribute largely to the advance of education, but if they do not, the money at their disposal will be frittered away, and the educational results be very small.

The school boards should, of course, develop the elementary education in the most efficient manner possible, and thus lay a good foundation for the higher and more special departments. They should take care that the education they afford is of such a nature as to lead to a love of real work, and, moreover, be of use to the scholars in the performance of that work. At present, it too often leads to a dislike of useful work, and turns out crowds of scholars who would rather starve on the pittances of clerks than soil their fingers or take off their coats. If the school boards felt so inclined, they might do as the Old Monkland Board

has done, and take advantage of the provisions of the Technical Schools Act, and found technical schools wherever they thought they were required; but since that Act was passed, as I have stated, considerable sums of money have been placed at the disposal of the other bodies whom I have mentioned, and, in the first place, it is desirable to take advantage of these as far as possible. Care must be taken, however, that none of the money which is designed for special purposes is used for the ordinary work of the school boards, for, otherwise, the only result would be a slight reduction of the local rates, and not an advancement of education.

Some of the secondary day schools might be utilised for advanced evening classes of a scientific or technical nature, and the teachers could continue the work of their day scholars in some of the advanced subjects. In fact, good secondary scientific education is the best form of technical education, and likely to lead to far more useful results than scraps of science intended for immediate practical application. Those who have received a good general education, including the principles of science, will have little difficulty in learning the practical applications to their daily work.

It would be out of place if I attempted at present to delineate a detailed scheme for the West of Scotland, for that could only be done after a careful study of the circumstances of the different districts. An outline sketch, however, of the main lines that I would suggest may be useful. First—with regard to Lanarkshire—as I have already mentioned, the Old Monkland School Board have provided a Technical School at Coatbridge, which, in addition to instruction in the more general departments of science, gives special facilities for the study of the subjects which are applied in the industries of the district. Similar schools should be instituted at Hamilton and Wishaw, and from these, and the Glasgow and West of Scotland Technical College, as centres, the special work in the various districts could be undertaken. Each of the above-mentioned schools, being in the midst of a considerable population, would be able to supply the greater part of the wants of those in the immediate neighbourhood, and even for considerable distances round about, as railway communication is now so good. Where the distance is too great, or communication difficult, teachers should be sent from the centres to the outlying districts, and take with them the special apparatus they require, although the more common appliances should be supplied to the local day schools, and be made available for the special evening classes.

Similar arrangements should be made for the other counties in the West of Scotland. For Renfrewshire, there ought to be central schools in Paisley and Greenock; for Dumbartonshire, in Dumbarton, and possibly Kirkintilloch; for Ayrshire, in Ayr, Kilmarnock, and probably one or two other places; for Argyleshire, Campbeltown and Dunoon; and for the other counties as might be arranged, for some of these might prefer to have Edinburgh rather than Glasgow for their head centre.

If the various local school boards encouraged the teaching of elementary science, with some of its applications to the industries of the districts, in their ordinary schools, with the organisation which I have suggested, there would be arrangements which would meet the requirements of all classes of the community. The scholars would continue their day-class work in the special evening schools, and the great majority would obtain all they required in the district in which they lived. The more advanced would proceed to the higher classes of the central schools, while the best scholars in these schools would go on to the Technical College or the University, and have opportunities for carrying on their studies to the highest possible standard, and for some of these bursaries or scholarships ought to be provided.

There would, in this way, be afforded opportunities for training in the subjects required in the industries of the different districts, and chief among those would be agriculture, for it is now being recognised that the great body of the people require to be brought into closer contact with the earth. Perhaps, in the not very distant future, More's ideal of Utopia may be realised, and agriculture be so universally understood among the people, that no man or woman will be ignorant of it, and, at the same time, the delightful manner of life which More pictures be brought within the reach of the great masses of the people.

Two years ago, a special committee of the Governors of the Technical College, of which I am convener, was appointed for the purpose of meeting with representatives of institutions or organisations in the West of Scotland, and co-ordinating the work of each, so that economy and efficiency might be promoted. That committee, however, has not yet taken any action, as it was thought desirable to allow the different localities to take the initiative with the funds which had just been placed at their disposal for secondary and technical education. It seems to me, however, that the time is now ripe for, at least, a beginning of the work, which should lead before long to a strong union, which

would be of the greatest service in advancing the interests of education in the West of Scotland. It would also complete the organisation which I indicated as necessary in my paper of ten years ago.

In order that the work may develop in accordance with the requirements of the different districts, and be moulded to a considerable extent by the individualities of the teachers, the local authorities should, as I have stated, be at liberty to make arrangements to suit the conditions and occupations of the people. There should be, however, in addition to the consultative or advising committee that I have already suggested, a central executive body with sufficient authority to co-ordinate the different agencies, so that there may be no unnecessary over-lapping and waste of energy and money. At the same time, great care must be taken that the whole work does not degenerate into a mere matter of business, entirely awanting in the true educational spirit. In the matter of education it is still true to a very large extent that we are a nation of shopkeepers, and only take up with anything like enthusiasm what pays directly, forgetting that the really valuable part of education cannot be measured for payment.

In my former paper I said:—"The Technical Institute of Glasgow (or, as I would prefer to see it named, of the West of Scotland) should be a corporation which, taking advantage of existing institutions in so far as they served its special purposes, supplemented what was wanting in them, so that together they might afford the instruction necessary for the different industries, and, by the standard maintained in its higher departments, indirectly controlled the teaching in the secondary schools; and which aided, both pecuniarily and by sending them properly-qualified teachers, such schools as afforded instruction chiefly to the working classes in the principles which they applied in their every-day work, all the various kinds of institutions forming, not a heterogenous lot of atoms, but a well-ordered system, by which the educational wants of every section of the industrial community might be properly supplied." I think that a survey of what has been done during the past ten years will show that all the proposals which I made have been carried out to a very considerable extent, and I have no hesitation in saying that the further developments which I have indicated are all possible within the next ten years, if gone about in an intelligent manner, and that Glasgow might then become the most important centre for scientific and industrial education in the world.

PRESIDENTIAL ADDRESS TO THE ECONOMIC SCIENCE SECTION.

IV.—*A Living Wage.* By WILLIAM SMART, M.A., LL.D.

[Read before the Section, 27th November, 1893.]

WHEN your Section did me the honour to nominate me to the position made doubly honourable by your late president, Dr. Charles Gairdner, I felt it my duty to take for presidential address the subject which is now agitating our industrial world. If the Economic Section is not able either to give or to procure some light on the economic subjects in which people are at the moment interested, it has not much reason for its existence; and so long as I have the honour of directing the affairs of the Section I shall try to make our meetings the arena where present-day industrial and social questions are freely discussed from all points of view.

The last few weeks have seen the birth of a new and attractive catchword. Before it has even been defined, it is already put forward as asserting a claim. It seems to go on the same lines as two old sentiments—namely, "The labourer is worthy of his hire," and "A fair day's wage for a fair day's work;" but while these latter, if undeniable, are quite harmless, the expression "living wage" seems to give a reason and basis for a certain wage. It has, accordingly, found its way into the newspapers, and we may expect soon to find that the conception which it expresses has taken its place among the convictions of multitudes. It seems to me, then, of the highest importance that, before it goes further, this catchword should itself be caught, and put under the economic microscope.

The first thing to be noted is the ambiguity of the expression. It is, perhaps, some centuries since the British working man lived at the physical level of subsistence. In the middle of last century, that is to say, just before the industrial revolution which flooded England with the new wealth from manufacture, he lived on wheaten bread, had meat, perhaps, twice a week to his dinner, and tea once a day; and, as the signboards abundantly testified, he could get "drunk for a penny, and dead drunk for twopence,"

These things are all in excess of the physical level of subsistence, and yet they represented a living wage in days when there was neither a canal nor a spinning mill in England, when smelting with coal was the latest novelty, and when James Watt had not yet taken that memorable Sunday afternoon walk on Glasgow Green which was to date the birth of the steam engine.

The greatest living authority in English economics, Professor Marshall, has laid down the following as "necessaries for efficiency" of an ordinary agricultural labourer, or of an unskilled town labourer, and his family:—"A well-drained dwelling, with several rooms, warm clothing, with some changes of underclothing, pure water, a plentiful supply of cereal food, with a moderate allowance of meat and milk, and a little tea, &c., some education, and some recreation, and, lastly, sufficient freedom for his wife from other work to enable her to perform properly her maternal and her household duties. In addition, perhaps, some consumption of alcohol and tobacco, and some indulgence in fashionable dress, are, in many places, so habitual that they may be said to be 'conventionally necessary,' since, in order to obtain them, the average man or woman will sacrifice some things which are necessary for efficiency." And Professor Marshall translates this into figures by saying, "Perhaps, at present prices, the strict necessaries for an average agricultural family are covered by 15s. or 18s. a week, the conventional necessaries by about 5s. more; for the unskilled labourer in the town, a few shillings must be added to the strict necessaries."

You will find this comes out approximately at the figure named by the London County Council for town labourers, of 24s. a week, and we shall take that figure as a convenient basis of calculation. This, then, conclusively indicates the ambiguous nature of the expression. The "living" referred to is not physical subsistence. The "living wage" is a minimum wage based on the present high level of national wealth. It is what Ricardo called the "natural" wage, and was careful to define as "essentially depending on the habits and customs of the people."

The first question I shall raise, then, is as to the possibility of this living wage. The money income of this country was estimated in 1889 at £1,285,000,000 a year. Divided among our 35,000,000 of population (Census 1881), this would give, roughly, £33 of income per head. Now, I think I am not wrong in saying that £33 a year of wage is below the level of living of the average

British workman. But, of course, this is not the proper way of reading the statistic in question. The average household in Great Britain consists of five persons, and an equal division of income would allow to each household a collective annual wage of £165. Suppose the family to consist of the wage earner, his wife, and three young children, it is obvious that £33 per head, thus multiplied, gives very much above what we should naturally call a living wage per family. Suppose, then, we take the more modest figure of 24s. as the living wage per family of five. Let us see how the national income would divide out on the basis of allowing this wage to one-third of the working classes.

In 1889 the working-class families of Great Britain were estimated by Mulhall at 4,774,000; trades classes at 1,220,000; middle classes, 604,000; and gentry, 222,000. Suppose we allow £100 a year for the remaining two-thirds of the working classes, and £150 a year for the trades classes, this gives us as follows:—

1,591,300	working families	at	24s. per week,	99,297,120
3,182,700	,,	,,	£100 per annum,	318,270,000
1,220,000	trades	,,	£150 ,,	183,000,000
				£600,567,120

This leaves for distribution among the other two classes £684,432,880.

The reason why I bring forward these figures is simply to answer those who say that the country is too poor to allow of a living wage. But since nothing is so misleading as facts, except figures, let me explain what, to my mind, these statistics show. They show that it is not impossible that every working-class family in Great Britain might have at least this living wage, supposing that, by some means or other, the living wage became a first charge on the national income. They further show that to allocate this amount of wage to the lowest class of wage earners would not reduce the other classes to a dead level. Two-thirds of the working classes might have about £2 a week; the trades classes, incomes averaging £150 a year, the amount just on the line of liability to income tax; the middle classes would have their present average of about £400; and the upper classes an average of £2,000, which, considering how many of them actually live under that figure, would still allow a good many to have incomes indefinitely over the £2,000.

You will mark that the figures do not in the least indicate what we might expect under any new organisation of society. The Socialists would assert that, if production were regulated and directed with the sole view of raising the general level of wealth and comfort, and if the making and, consequently, the consumption of foolish and wasteful forms of wealth came to an end, the increase of wealth per head would be so great that every family of five should have within its reach every luxury reasonable for health and culture. On the other hand, the Individualists would assert that the introduction of a regulated, uncompetitive system would so take away the motive to hard work, so disorganise the fine web of industrial organisation, and so frighten away capital to other countries, that the level all over would be indefinitely below the wealth now represented by the incomes named.

What I want to make clear is, that I am not presenting figures of what might happen under any other system than the present, but merely showing what are the theoretical possibilities of the *present* income allowing, at least, a living wage to all the working classes.

It must be noted, however, that the possibility indicated is conditioned by two assumptions. *First*—It assumes that the present proportion between increase of population and increase of wealth continues. A few years ago Mr. Giffen said that wealth in Great Britain was increasing more than twice as fast as population. If the living wage, by encouraging early marriages and improvidence, raised the sluice gates of population, while it lowered the death-rate among children, the proportion between wealth and population might alter, although, I think, the probability is that the growth of wealth will yet proceed still more rapidly,—particularly as the last census shows that the rate of increase of population in Great Britain is slowing down. *Second*—It assumes that, over the field of the world, the law of diminishing returns of land produce will not rise into unwelcome prominence. At present the world is being drawn so close together by steam communication that only the most fertile lands over the whole field of the civilised nations need be cultivated, and the price of wheat is still falling. So long as this is the case, we may subsume food under the category of general wealth, and neglect the consequences that will undoubtedly ensue later on, when the world becomes more crowded than it is.

One other consideration emerges here, and it is one which does not

British workm[illegible] that the figures of national reading the [illegible]sing power only. Whether Britain co[illegible] much or little depends on would all [illegible] its wealth and directed its Suppose [illegible] labour, and capital of the country three [illegible] potatoes, potatoes will be cheap. If they multi[illegible] flowers, flowers will be cheap. And call [illegible] potatoes or more flowers are grown, will mo[illegible] be cheap. But cheap potatoes and cheap us [illegible] the same importance to people on 24s. a week. [illegible] the wealth-giving power of the 24s. depends [illegible] whether the advances in production have been in the [illegible] necessaries or in the sphere of luxuries. Just now a [illegible] proportion of the working man's income *must* be spent on [illegible] rent and meat. But while prices generally have fallen over [illegible] per cent. in the last twenty years, house rent and meat are the two striking exceptions. Now these two things bear a much smaller proportion to the income of the rich. It is a common calculation in the West-End that rent should not be more than one-tenth of expenditure. But the rent of the cheapest house in the East-End is probably 2s. 6d. per week, which is a much larger proportion of, say, 18s. or 20s. of wage.*

I take a peculiar pleasure in quoting these statistics of income per head and per family, for, to my mind, they very conclusively demonstrate what a great many people do not, I think, realise—that, with all our wealth, we are a very poor country; and that, if the rich do not make their surplus go as far as wealth will go, by spending it wisely and socially, the state of the poor must be very bad. Luxury, when it takes the form of consuming the product of a great deal of labour and capital by one human stomach, or wearing it out on one human back, *is* culpable, if there is not enough wealth to go round us all. And while a great deal of rich people's income is mostly transferred to others in exchange for services, there is a very great deal of expenditure which is not simply transfer, but involves great destruction of wealth, and this destruction takes away large amounts from the possible consumption of the multitude. I think the fact that an equal division of our present income would

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* From a statistical investigation recently made in London, based on nearly 30,000 returns, rent was found to be 23½ per cent. of wage (6s. 2d. rent to 26s. 2d. wage.)—*Journal of the Statistical Society*, June, 1893.

give us no more than £165 per family is one that speaks as strongly against the present state as it warns us against expecting too much of any other. But if it is true that an equal distribution would not make us all more than comfortable, what does it tell us of the present unequal distribution?

What I have said refers to the theoretical possibility of a universal living wage. The statistics, indeed, do not prove very much, but it is surely something to find that the claim of a living wage is not the cry of children for the moon, but a claim which we may seriously consider without fearing that it involves a levelling down of all incomes to a similarly low figure.

We pass now to a much smaller subject—to consider the living wage in its present practical form of a demand from our 600,000 miners alone. As regards scope, it cannot be a claim that any miner who applies shall be employed, and paid at least a minimum wage. That need not, I think, be argued. It is merely a demand that, where a miner is employed, he shall not be paid less than a certain wage. It does not involve the "right to employment."

As regards sanction, this prohibition to pay the miner less than a certain wage might emanate from Parliament—although I do not think it has much chance of so emanating: if Parliament ever goes that length, it will be going much further at the same time—or it might become current as a "law of the trade." The trade unions alone probably could not enforce it, but, as there are now very strong organisations on either side, if pressed by the unions, it might be accepted by the masters generally, and pass into the unwritten law of the trade so thoroughly that the exceptions to its operation would be trifling. Or it might come about, as in the case of wages in some women's industries, where a strong public opinion that less than 10s. a week can scarcely keep single women in honourable and decent life, has very generally fixed that wage as a minimum which employers do not try to reduce. I should like to think that an enlightened public conscience will gradually extend this beyond a few factories in Paisley and Glasgow.

But, however strong its sanction, one result would, I think, inevitably follow. Only those who were considered worth the minimum wage would be employed in the pits. Just now it may pay a master to employ a second-rate miner, and pay him a lower

wage. But the lower wage being forbidden, the immediate consequence would be that the masters would weed the pits of all who were not worth the wage. I need not remind you that, even where work is paid by the piece, it is not the same to the employer whether the miner produces his ton of coal in three hours or in four; there are all the running expenses of fixed and auxiliary capital to be considered, as well as the management expenses.

From this it will be seen that, as regards the masters, the demand of a minimum wage is not so grave a matter as some people think. It is not over-paying bad work. It is paying a minimum for good work. There is no greater fallacy than the idea that high wages spell high cost of production. We long ago came to the conclusion in economic science that "cheap" labour is generally dear labour. Indeed, it seems to me that the proposal —which is often condemned as Socialistic—is strongly the other way. So far as the miners are concerned, it is no less than the "survival of the fittest," for the unfit would be forbidden work and wages. And it transfers the problem from mining to the other industries which this unfit labour would invade.

So far there is nothing very startling about the proposal. My objection to it is that it does not meet the problem at all. But this we shall see better when we have considered the connection between wage of labour and price of product.

A common impression, based on some such sentiment as "A fair day's wage for a fair day's work," is that a person who works fairly with his hands *earns* at least his maintenance. But this is demonstrably incorrect if he labours at something which the world does not want, whether that arise from absence of demand or presence of over-supply. The impression, however, has a rational root in the fact that, in a new country, the earth is generally bounteous enough to repay a year's cultivation with a year's maintenance. But what is the meaning of the division of labour under which we live? It means that a man gives up his independent individual action; that he becomes one of a group of co-operators; that every product is made by the continuous and successive labour of several classes and groups of workers; and, finally, that the products are not divided out directly among the workers, but are first sold—that is to say, the workers are not paid by a portion of the products, but by a portion of the value which these products realise. In this way the product of labour as a whole becomes indefinitely greater.

But it is accompanied by this serious drawback, that no man can work alone; that no man can command a wage; and that no man is paid by what he directly makes. Even the crofter does not rear his stirks to eat, but to sell; and is paid, not in their flesh, but in their price.

What the miner produces is coal. But he is not paid in this coal, nor would he want to be. He is paid out of the price of the coal, or, strictly speaking, out of the anticipated price of the coal, advanced by the employer, and replaced by the price. Now, what determines the price of coal? For answer, we look to the consumers. To the householder, coal, in the absence of wood, is a necessary of life. The household consumers of coal would, undoubtedly, give a price much above any ordinary level rather than do without, although they would indefinitely reduce their demand according as they could economise or find substitutes.

But household consumption is less than one-fourth of the output. The large demand comes from the industries of the country as a "cost" in their production. What regulates the price which they can pay for coal? They cannot, on the whole, pay more than they can get back by the selling prices of the goods which they make, and out of this price must come, of course, profits.

This leads into a wide field, for England is, *par excellence*, the world's provider, and this reminds us that the price realised by our exports—namely, £309,000,000—is regulated by the competition of every nation which manufactures similar goods. Our manufactures are running a race with those of America, Europe generally, and the East, and, so far as that is the case, the price our industries can pay for coal is determined by English manufactures being able to meet the competition of these countries.

Thus, in the case of coal, more, perhaps, than in the case of any other commodity, the direct connection between wages and price is difficult to follow. But one thing seems to emerge with great clearness,—that, in these circumstances, the producer of coal can not dictate his prices for coal. His cost of production does not necessarily regulate the price which he gets. If the British manufacturing cost of production exceeds a certain figure, some of the British industries which are based on coal stop, and the coal production, to that extent, stops also.

This becomes even clearer if we look at our export of coal itself. Coal, of course, is not a product of England alone. It can be produced in Germany, it is said, at 6s. 9d. a ton, and in the United

States at less than a dollar. The moment that the cost of production of foreign coal, delivered at a mutual market, comes below our cost of production, some of our mines have to shut.

Now, it is advisable to point out here that, even suppose an international agreement were made with the whole world, whereby coal miners everywhere should be paid a living wage, it would not secure us. If the principle of a living wage is to hold for English labour, it must hold further than that. I have already shown that the living wage demanded by our miners is not a subsistence wage, but a minimum determined by a customary level of comfort, and based on the national wealth. We cannot, however, ask more of any other nation than that it pay its workers a wage based on *their* customary level of comfort—that is to say, a wage which has regard to the wealth of that nation. But no one would, I imagine, maintain that the wealth of Russia, for example, could permit the payment to its colliers of 24s. a week. Still, if this is so, how could even that impossible ideal of an international living wage prevent the coal of other countries from underselling us, if the other conditions of the industry were equally favourable?

This, then, is the argument most often used against any organisation which aims at keeping up mining wages. England must have cheap coal, if she is to remain what she is. Wage is the largest element in the cost of production of coal; consequently, there must be no artificial barrier in the way of making miners' wages as low as necessary to compete with the world which buys our coal and our manufactures.

It is not a pleasant argument. It sounds to me as if we proposed doing with the miners what a general is sometimes forced to do when it is absolutely necessary to gain time, and he orders out a regiment to hold a position where he knows it will be cut to pieces. But if you admit the premiss, "England must have cheap coal," you must face the conclusion fairly and squarely, and not shut your eyes to it.

To all this there is, however, another side. I have said that it is, in the last resort, the consumers who determine the price. Whatever the cost of production be, the consumer will not pay *any* price that may be asked, but only pay such a price as he finds he can get due return for, either in support of life or price of product.

But there is, under modern conditions, another influence that

has a great share in determining price. It is that, in many cases, the producers do not wait on demand to declare itself, but tempt demand; they knowingly offer a lower price than the consumer would be willing to pay. This is said to be the present position in a very aggravated degree. It is freely stated that it is the reckless competition of coalmasters among themselves that has run down the price of coal,—indeed, that many contracts were made, before this last strike, in anticipation of the masters being able to force a reduction of wage on the men. We are reminded that not only has the consuming world opposing interests to the producing world, but that producers have opposing interests to each other. The gas companies and the railways make their contracts six months to a year ahead, and it is these contracts that have been taken in this ruinous way. It is also pointed out that, by the strike clause, inserted in almost every contract, the masters are set free of their liability to deliver at contract prices during a strike. So that, if they contract at unprofitable prices, and then are not able to reduce wages in conformity, it is their interest to force matters to a strike, or lock the miners out, in which case the cheap contract lapses.

It is in this belief, evidently, that we have the genesis of the demand for a living wage. Wherever the sliding scale is adopted, wages follow, at a certain interval of time, the price of coal. But while this admittedly gives a very fair division of a rising price between masters and men, it provides no safeguard against large producers taking very low contracts, and keeping down the wage. This grievance has been provided for by the last sliding scale for South Wales, where contracts running for over a year are not taken into account beyond twelve months in determining the average net selling price on which wage is based. It is, in fact, the knowledge that masters, by competing with each other, do determine the price of coal at a lower level than seems necessary, that has educated the men to this demand of a living wage. "If they can do so much with prices and wages, they can surely do a little more, and fix a minimum wage."

Those who dwell on this argument urge, then, that it is not foreign competition that is the enemy of wage. They say that England possesses such advantages, both in coal measures and in transit, as to be out of reach of legitimate foreign competition; but if labour, like all other factors, is paid out of price, and price is determined, not by the competition of producers and

consumers, but by producers fighting among themselves, the price which would otherwise pay both capital and labour will pay neither.

There is no attempt in this argument, as is sometimes said, to deny that prices are fixed by the equation of supply and demand. But here, it is said, is an operation which gets behind demand and bribes it. The natural protector of the worker is the employer: seeing that good prices mean good wages as well as good profits, it is his duty to get the best price he can. But for the leaders of the industrial army to *tempt* demand is to betray their men. Instead of fighting for the best price, they offer the lowest, and then try to save their own pockets by rolling the burden on to the men. It is certainly an evidence on this side, that it is the great gas companies at home, usually paying large dividends, who have got coal at the lowest contract price,—not the manufacturers who make goods for export, and compete with the world.

It is not for an outsider to say how much or how little truth there is in this assertion of cynical purpose. It would be difficult to distinguish between a contract made with the intention of pressing down wages and a contract taken in the anticipation of wages coming down. In all trades there are capitalists who may almost be counted on to cut prices on the—often remote—chance of recouping themselves by a larger turnover, and, perhaps, by securing a new clientèle. But the prudent coalmaster is not likely to forget that the tenure of his pits is a limited one, and that profit thrown away towards the middle or end of a lease will not be recouped even to his successors. He is thus more likely than most capitalists to "make his hay while the sun shines." And, again, coalmasters know better than most people that a strike never pays, and that the lapse of contracts during a strike is a poor set-off to the expenses of management and of keeping the mine clear, which run on whether coal is being raised or not. But it is certainly a pity that the very low price of some contracts still running should give occasion to this suspicion.

I cannot, however, admit that the question of foreign competition *can* be dismissed, seeing that, of the total coal production of 181,000,000 tons, 55,000,000 go to manufacturing industries, and 29,000,000 are exported. Thanks to our natural advantages of coal, and iron, and sea carriage, and our early adoption of Free Trade, we long ago set ourselves the industrial mission of providing the

world with manufactures. An immense quantity of the national capital is locked up in the great and expensive plant necessary for that purpose. We have supplied the world, not only with commodities, but with the means of making them. And we go on preaching Free Trade as an international gospel, forgetting, I think, that the triumph of Free Trade may not be the triumph of Great Britain.

What is the principle of Free Trade? It is that each country should make that for which it is particularly well adapted, and supply itself and its neighbours with that. As a fact, the wrong-headed policy of our neighbours has allowed us to go on supplying the world with many things for which we are not particularly well adapted, and the time is coming—I am afraid it now is—when other countries will supply themselves with many things which we have hitherto made for them. But if we are still to compete with a whole world to sell our manufactures, we must meet the world's prices. If our superior skill, and machinery, and natural resources, are not greater than theirs, our *labour cost* must not be greater. If—I only say "if"—we are attempting to compete with other countries in things for which they have better natural advantages than we have, we must take the consequences. It will then be the old story of the hand weavers competing with the power looms—a long process of encroaching poverty before extinction. If English capital builds mills in Bombay, fills them with English machinery, buys its cotton on the spot, and then is able—which it is not yet, of course—to make the Hindoo as skilful and lasting a worker as the English spinner, how long will it be before Lancashire has to reduce its wages?

But we may leave the question of foreign competition on one side just now, for this reason, that there are sufficient difficulties about the living wage nearer home. If we do so, the question seems to narrow itself down to this—Is it possible to make the living wage a necessary part of the cost of coal?

It is contended by some, both masters and men, that, if masters had to reckon with a certain minimum cost of wage, they would be more careful with their quotations, and rather endeavour to get a high price at once than trust to get their profit from a larger turn-over after cutting out their neighbours. At any rate, if they did accept too low prices, their folly would affect only themselves.

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trades, by agreement between unions of men and unions of masters, wages are fixed ahead for periods of six months and a year. And, of course, professional fees are fixed for much longer periods.

But I am afraid, again, that all this is not to the point. Let us assume a much more favourable case—namely, that the price of coal, by some great confederation of masters and men, is fixed and maintained at such a price as will pay good wages, besides reasonable interest and profit. It does not seem to me impossible —with the reservation that we can get over the difficulty of foreign competition—to maintain such prices and wages, provided one condition be observed.

What that condition is may be illustrated from a trade which is conducted on these principles—the cotton thread trade. Here we find not a forced or legal, but a natural monopoly, partly due to the prejudice of the public for an old-established brand, and partly to the immense capital involved. In this trade the price of thread is maintained so long as the thread firms agree among themselves, no matter what be the fluctuation in the price of raw cotton, or of demand for finished goods. But what does this involve? It involves, first, a large amount of machinery in excess of the average employment, which can be set going when wanted, and it involves periods of short time—sometimes of very short time.

Suppose, then, that the price of coal over Great Britain has been fixed at such a price as to afford the living wage, and pay such interest and profit that capital will not strike. So long as the fluctuations of demand are always on the upper side of the average supply, everything may go well. The spurts of demand can be supplied from the surplus plant which we may assume to be at the command of the united collieries.

But now, suppose that demand slackens off. The supposition is not absurd, although people interested in coal will scarcely believe it. It fell off, for instance, about four million tons between 1891 and 1892. When our best engines allow between 80 and 90 per cent. of the energy generated in combustion to escape unused, there is evidently a very large field for economies in coal. And we are only now experimenting with substitutes like electricity and oil, which do, indeed, require some use of coal, but at the same time supplant other uses. A few years ago America would scarcely have imagined that one-fourth of her rolling mills and steel works would be driven by natural

gas, displacing coal to the extent of $9\frac{3}{4}$ millions of tons.* In many ways, at any rate, a slackening-off of demand is possible. Where there is no fixed price, such a falling-off is met by a tempting of demand—a reduction of price; and the lowered price generally finds a wider circle of demand, which takes up all the supply at that price, and more. But if the price of coal is fixed, then coal accumulates on the pit bank, and sooner or later the collieries go on short time. With that the "living wage" disappears.

This, then, is why I hinted that certain arguments, which were strong enough in support of one thing, were quite beside the mark as regards the subject we are now discussing. I fear that the miners, as well as some other people, have been forgetting that a *minimum* wage per ton, or per day, is not necessarily a *living* wage—if we mean anything by the expression. Perhaps it will be thought that this is a quibble. As a fact, it goes to the very heart of the matter. Why are the miners asking a "living wage?" Because, as they say, they must *live* on their wage. What does this practically mean? Do they claim 4s. a day for 6 days, or 6s. a day for four days? It does not matter which. My point is, that, if 24s. a week is just enough to live on, 4s. a day will not give them a living wage, if they get less than six days a week; and 6s. a day will not give them a living wage, unless they get four days a week. And whether they can get the requisite number of days per week or not, seems to me to depend on a factor that is outside of and beyond the power of masters or men to control—namely, the quantity of coal demanded. I may remind you that, in some districts, the miners are claiming 7s. a day as a living wage, which evidently assumes a normal week of four days or so. If they work more days a week, they get more than they ask,—which was simply a wage to live on; if they work less, they cannot live on the living wage which they ask!

I venture to think that what has been said is not wasted, if we have got our minds clear on this fundamental difference between a living wage and a minimum wage. But the necessity of clearing up this ambiguity has left me little time to say very much of the two questions, so far as they are separate and distinct.

Frankly, I cannot see that any power, except the State, can

* The figures are for 1887.—Wells: "Some Economic Changes."

get the attention that it deserves. It is that the figures of national income just given are figures of purchasing power only. Whether the various money incomes will buy much or little depends on how the community has embodied its wealth and directed its energies. If the limited land, labour, and capital of the country are invested in growing potatoes, potatoes will be cheap. If they are invested in growing flowers, flowers will be cheap. And according as more potatoes or more flowers are grown, will potatoes or flowers be cheap. But cheap potatoes and cheap flowers are not of the same importance to people on 24s. a week. In other words, the wealth-giving power of the 24s. depends greatly on whether the advances in production have been in the sphere of necessaries or in the sphere of luxuries. Just now a large proportion of the working man's income *must* be spent on house rent and meat. But while prices generally have fallen over 30 per cent. in the last twenty years, house rent and meat are the two striking exceptions. Now these two things bear a much smaller proportion to the income of the rich. It is a common calculation in the West-End that rent should not be more than one-tenth of expenditure. But the rent of the cheapest house in the East-End is probably 2s. 6d. per week, which is a much larger proportion of, say, 18s. or 20s. of wage.*

I take a peculiar pleasure in quoting these statistics of income per head and per family, for, to my mind, they very conclusively demonstrate what a great many people do not, I think, realise—that, with all our wealth, we are a very poor country; and that, if the rich do not make their surplus go as far as wealth will go, by spending it wisely and socially, the state of the poor must be very bad. Luxury, when it takes the form of consuming the product of a great deal of labour and capital by one human stomach, or wearing it out on one human back, *is* culpable, if there is not enough wealth to go round us all. And while a great deal of rich people's income is mostly transferred to others in exchange for services, there is a very great deal of expenditure which is not simply transfer, but involves great destruction of wealth, and this destruction takes away large amounts from the possible consumption of the multitude. I think the fact that an equal division of our present income would

* From a statistical investigation recently made in London, based on nearly 30,000 returns, rent was found to be 23½ per cent. of wage (6s. 2d. rent to 26s. 2d. wage.)—*Journal of the Statistical Society*, June, 1893.

give us no more than £165 per family is one that speaks as strongly against the present state as it warns us against expecting too much of any other. But if it is true that an equal distribution would not make us all more than comfortable, what does it tell us of the present unequal distribution?

What I have said refers to the theoretical possibility of a universal living wage. The statistics, indeed, do not prove very much, but it is surely something to find that the claim of a living wage is not the cry of children for the moon, but a claim which we may seriously consider without fearing that it involves a levelling down of all incomes to a similarly low figure.

We pass now to a much smaller subject—to consider the living wage in its present practical form of a demand from our 600,000 miners alone. As regards scope, it cannot be a claim that any miner who applies shall be employed, and paid at least a minimum wage. That need not, I think, be argued. It is merely a demand that, where a miner is employed, he shall not be paid less than a certain wage. It does not involve the "right to employment."

As regards sanction, this prohibition to pay the miner less than a certain wage might emanate from Parliament—although I do not think it has much chance of so emanating: if Parliament ever goes that length, it will be going much further at the same time—or it might become current as a "law of the trade." The trade unions alone probably could not enforce it, but, as there are now very strong organisations on either side, if pressed by the unions, it might be accepted by the masters generally, and pass into the unwritten law of the trade so thoroughly that the exceptions to its operation would be trifling. Or it might come about, as in the case of wages in some women's industries, where a strong public opinion that less than 10s. a week can scarcely keep single women in honourable and decent life, has very generally fixed that wage as a minimum which employers do not try to reduce. I should like to think that an enlightened public conscience will gradually extend this beyond a few factories in Paisley and Glasgow.

But, however strong its sanction, one result would, I think, inevitably follow. Only those who were considered worth the minimum wage would be employed in the pits. Just now it may pay a master to employ a second-rate miner, and pay him a lower

wage. But the lower wage being forbidden, the immediate consequence would be that the masters would weed the pits of all who were not worth the wage. I need not remind you that, even where work is paid by the piece, it is not the same to the employer whether the miner produces his ton of coal in three hours or in four; there are all the running expenses of fixed and auxiliary capital to be considered, as well as the management expenses.

From this it will be seen that, as regards the masters, the demand of a minimum wage is not so grave a matter as some people think. It is not over-paying bad work. It is paying a minimum for good work. There is no greater fallacy than the idea that high wages spell high cost of production. We long ago came to the conclusion in economic science that "cheap" labour is generally dear labour. Indeed, it seems to me that the proposal —which is often condemned as Socialistic—is strongly the other way. So far as the miners are concerned, it is no less than the "survival of the fittest," for the unfit would be forbidden work and wages. And it transfers the problem from mining to the other industries which this unfit labour would invade.

So far there is nothing very startling about the proposal. My objection to it is that it does not meet the problem at all. But this we shall see better when we have considered the connection between wage of labour and price of product.

A common impression, based on some such sentiment as "A fair day's wage for a fair day's work," is that a person who works fairly with his hands *earns* at least his maintenance. But this is demonstrably incorrect if he labours at something which the world does not want, whether that arise from absence of demand or presence of over-supply. The impression, however, has a rational root in the fact that, in a new country, the earth is generally bounteous enough to repay a year's cultivation with a year's maintenance. But what is the meaning of the division of labour under which we live? It means that a man gives up his independent individual action; that he becomes one of a group of co-operators; that every product is made by the continuous and successive labour of several classes and groups of workers; and, finally, that the products are not divided out directly among the workers, but are first sold—that is to say, the workers are not paid by a portion of the products, but by a portion of the value which these products realise. In this way the product of labour as a whole becomes indefinitely greater.

But it is accompanied by this serious drawback, that no man can work alone; that no man can command a wage; and that no man is paid by what he directly makes. Even the crofter does not rear his stirks to eat, but to sell; and is paid, not in their flesh, but in their price.

What the miner produces is coal. But he is not paid in this coal, nor would he want to be. He is paid out of the price of the coal, or, strictly speaking, out of the anticipated price of the coal, advanced by the employer, and replaced by the price. Now, what determines the price of coal? For answer, we look to the consumers. To the householder, coal, in the absence of wood, is a necessary of life. The household consumers of coal would, undoubtedly, give a price much above any ordinary level rather than do without, although they would indefinitely reduce their demand according as they could economise or find substitutes.

But household consumption is less than one-fourth of the output. The large demand comes from the industries of the country as a "cost" in their production. What regulates the price which they can pay for coal? They cannot, on the whole, pay more than they can get back by the selling prices of the goods which they make, and out of this price must come, of course, profits.

This leads into a wide field, for England is, *par excellence*, the world's provider, and this reminds us that the price realised by our exports—namely, £309,000,000—is regulated by the competition of every nation which manufactures similar goods. Our manufactures are running a race with those of America, Europe generally, and the East, and, so far as that is the case, the price our industries can pay for coal is determined by English manufactures being able to meet the competition of these countries.

Thus, in the case of coal, more, perhaps, than in the case of any other commodity, the direct connection between wages and price is difficult to follow. But one thing seems to emerge with great clearness,—that, in these circumstances, the producer of coal can not dictate his prices for coal. His cost of production does not necessarily regulate the price which he gets. If the British manufacturing cost of production exceeds a certain figure, some of the British industries which are based on coal stop, and the coal production, to that extent, stops also.

This becomes even clearer if we look at our export of coal itself. Coal, of course, is not a product of England alone. It can be produced in Germany, it is said, at 6s. 9d. a ton, and in the United

States at less than a dollar. The moment that the cost of production of foreign coal, delivered at a mutual market, comes below our cost of production, some of our mines have to shut.

Now, it is advisable to point out here that, even suppose an international agreement were made with the whole world, whereby coal miners everywhere should be paid a living wage, it would not secure us. If the principle of a living wage is to hold for English labour, it must hold further than that. I have already shown that the living wage demanded by our miners is not a subsistence wage, but a minimum determined by a customary level of comfort, and based on the national wealth. We cannot, however, ask more of any other nation than that it pay its workers a wage based on *their* customary level of comfort—that is to say, a wage which has regard to the wealth of that nation. But no one would, I imagine, maintain that the wealth of Russia, for example, could permit the payment to its colliers of 24s. a week. Still, if this is so, how could even that impossible ideal of an international living wage prevent the coal of other countries from underselling us, if the other conditions of the industry were equally favourable?

This, then, is the argument most often used against any organisation which aims at keeping up mining wages. England must have cheap coal, if she is to remain what she is. Wage is the largest element in the cost of production of coal; consequently, there must be no artificial barrier in the way of making miners' wages as low as necessary to compete with the world which buys our coal and our manufactures.

It is not a pleasant argument. It sounds to me as if we proposed doing with the miners what a general is sometimes forced to do when it is absolutely necessary to gain time, and he orders out a regiment to hold a position where he knows it will be cut to pieces. But if you admit the premiss, "England must have cheap coal," you must face the conclusion fairly and squarely, and not shut your eyes to it.

To all this there is, however, another side. I have said that it is, in the last resort, the consumers who determine the price. Whatever the cost of production be, the consumer will not pay *any* price that may be asked, but only pay such a price as he finds he can get due return for, either in support of life or price of product.

But there is, under modern conditions, another influence that

has a great share in determining price. It is that, in many cases, the producers do not wait on demand to declare itself, but tempt demand; they knowingly offer a lower price than the consumer would be willing to pay. This is said to be the present position in a very aggravated degree. It is freely stated that it is the reckless competition of coalmasters among themselves that has run down the price of coal,—indeed, that many contracts were made, before this last strike, in anticipation of the masters being able to force a reduction of wage on the men. We are reminded that not only has the consuming world opposing interests to the producing world, but that producers have opposing interests to each other. The gas companies and the railways make their contracts six months to a year ahead, and it is these contracts that have been taken in this ruinous way. It is also pointed out that, by the strike clause, inserted in almost every contract, the masters are set free of their liability to deliver at contract prices during a strike. So that, if they contract at unprofitable prices, and then are not able to reduce wages in conformity, it is their interest to force matters to a strike, or lock the miners out, in which case the cheap contract lapses.

It is in this belief, evidently, that we have the genesis of the demand for a living wage. Wherever the sliding scale is adopted, wages follow, at a certain interval of time, the price of coal. But while this admittedly gives a very fair division of a rising price between masters and men, it provides no safeguard against large producers taking very low contracts, and keeping down the wage. This grievance has been provided for by the last sliding scale for South Wales, where contracts running for over a year are not taken into account beyond twelve months in determining the average net selling price on which wage is based. It is, in fact, the knowledge that masters, by competing with each other, do determine the price of coal at a lower level than seems necessary, that has educated the men to this demand of a living wage. "If they can do so much with prices and wages, they can surely do a little more, and fix a minimum wage."

Those who dwell on this argument urge, then, that it is not foreign competition that is the enemy of wage. They say that England possesses such advantages, both in coal measures and in transit, as to be out of reach of legitimate foreign competition; but if labour, like all other factors, is paid out of price, and price is determined, not by the competition of producers and

consumers, but by producers fighting among themselves, the price which would otherwise pay both capital and labour will pay neither.

There is no attempt in this argument, as is sometimes said, to deny that prices are fixed by the equation of supply and demand. But here, it is said, is an operation which gets behind demand and bribes it. The natural protector of the worker is the employer: seeing that good prices mean good wages as well as good profits, it is his duty to get the best price he can. But for the leaders of the industrial army to *tempt* demand is to betray their men. Instead of fighting for the best price, they offer the lowest, and then try to save their own pockets by rolling the burden on to the men. It is certainly an evidence on this side, that it is the great gas companies at home, usually paying large dividends, who have got coal at the lowest contract price,—not the manufacturers who make goods for export, and compete with the world.

It is not for an outsider to say how much or how little truth there is in this assertion of cynical purpose. It would be difficult to distinguish between a contract made with the intention of pressing down wages and a contract taken in the anticipation of wages coming down. In all trades there are capitalists who may almost be counted on to cut prices on the—often remote—chance of recouping themselves by a larger turnover, and, perhaps, by securing a new clientèle. But the prudent coalmaster is not likely to forget that the tenure of his pits is a limited one, and that profit thrown away towards the middle or end of a lease will not be recouped even to his successors. He is thus more likely than most capitalists to "make his hay while the sun shines." And, again, coalmasters know better than most people that a strike never pays, and that the lapse of contracts during a strike is a poor set-off to the expenses of management and of keeping the mine clear, which run on whether coal is being raised or not. But it is certainly a pity that the very low price of some contracts still running should give occasion to this suspicion.

I cannot, however, admit that the question of foreign competition *can* be dismissed, seeing that, of the total coal production of 181,000,000 tons, 55,000,000 go to manufacturing industries, and 29,000,000 are exported. Thanks to our natural advantages of coal, and iron, and sea carriage, and our early adoption of Free Trade, we long ago set ourselves the industrial mission of providing the

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Frankly, I cannot see that any power, except the State, can

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secure what I have endeavoured to define as a living wage—that is, let us say, a steady 24s. a week,—irrespective of work and demand. The State can always tax the whole of its citizens—or rather, I should say, the citizens, if they like, can always tax themselves—for the support of certain classes, and can do this so long as the citizens are content to stay in the country and be taxed. But I understand that we are not now discussing Socialism *versus* the present State, but what can be done under the organisation of the State that we have. We are dealing with private employers of labour, and the utmost that we can think of as a possibility is a fixed price for coal, and a fixed price for one portion of the labour. There is no fixed price for capital, nor is there a fixed wage for the other classes of labour. Therefore, if demand will not take off the entire production, and if the capitalists and upper labourers will not oblige the lowest class labour by sacrificing their profit and wage, the whole production must go on short time; in which case, as I have said, the living wage disappears, although the minimum wage may remain.

As to the possibility of a minimum wage, I have already suggested, by the analogy of the thread trade, on what principles and under what conditions it might be secured. The difficulties, of course, are very great. Instead of about a dozen mills, there are some thousands of collieries; and instead of nine or ten kinds of thread, there are seventy different kinds of coal delivered in London alone. The making of a fixed price for all these, and the maintaining of it over the collieries, would mean an infinitely stronger organisation on the side of the masters than any we have yet seen. And it will be remembered that one inexorable condition of maintaining such an arrangement is limitation of output when demand slackens off.

Short of this great reorganisation of the coal industry, a minimum wage might be introduced as part of a sliding scale. It did actually form part of the first Durham scale of 1877. The weak point here is that equity seems to demand that it should be balanced, if not by a maximum, at least by a slower progression on the part of wage when the price of coal goes above the "standard price." But actual experience points out a great difficulty in this. On the usual sliding scale the wages of one three-months' period are determined by the prices of the previous three months. If prices rise rapidly the miner gets impatient at his wage not following more quickly; he forgets that, when prices

fall, wages are correspondingly slow to follow them, and, as in 1889, he throws over the sliding scale. It may be imagined that, if the slowness of following an advance in price were accompanied by a check in the actual advance of wage, it would not tend to the maintenance of what is now very generally accepted as the best scheme yet devised for regulating wages.

Supposing, now, that the difficulties of a minimum wage have been weighed and found not insuperable, we have to face the question of foreign competition. It is only hiding one's head in the sand to blink the grave seriousness of this question. On this I have already said enough, but I may add, on the other side, that, under Sir George Elliot's scheme, which has received the approval of many of the great coalmasters, it is assumed that the economies in working would be such as to give this country another great advantage over other countries, and so secure us another lease of our office as world providers.

The question which suggests itself to me is this—If the minimum wage is only possible under very high organisation (that is to say, under organisations of men which would look after their interests better than they have yet done), is the minimum wage worth fighting for?

Let me point out that, if a real minimum wage be demanded —I do not mean a sliding scale minimum, but a minimum wage which would not rise except when wages generally rose,— it is asking mining labour to take up a new position in the distribution of product. Wages and profits alike being paid out of price of product, they both depend, absolutely speaking, for their greater or less, on the greater or less of price. The result of this, on the whole, is that in good times wages, with proper organisation, go very high; in bad times correspondingly low, just as profits sometimes go very high and at other times disappear. But now it is wished to change all this, and make the fundamental wage independent of fluctuations of price. The demand is, then, practically that the capitalist employer should buy out the wage earners for a fixed minimum wage.

Well, I do not think there is any impossibility about this. It involves, as I have shown, the exclusion from the pits of all those who, in the opinion of the masters, are not up to a certain standard of efficiency. But this minimum wage, being fixed and secured as a first charge on gross returns, would necessarily be a *low* wage; for every investor knows that he cannot make any

payment a first charge on an undertaking without being content with a low rate. I think there is already a close parallel in the factory wages of women in Scotland. Their average wage is about 10s. a week: it does not vary to any extent with price. I have reason to believe it is accepted by many employers as a fixed cost. But then it is a very low wage. I am by no means sure that the insistance on a minimum wage for men would not be throwing away the workers' birthright for a present mess of pottage, nor am I sure that it would allow the working classes the full share in the growing wealth of the community which they should have. And, as a matter of human nature, I do not think it *would* be maintained. Whenever prices of coal chanced to go up, the wage earners would be impatient of their fixed minimum level. This has been instanced once and again under the sliding scale. But if once they rebelled and demanded that the minimum should be raised for a passing rise in price, the whole principle would go; for evidently the masters would also exact, in all justice, that on a passing depression of price the minimum must fall.

A minimum wage, in fact, would be like a mortgage charge on a manufacturing company, which remains fixed and unchanged whatever the profits of the concern may be. But when the mortgage holders are human beings at the verge of a living, we must expect the weakness of human nature from them.

It is for this reason that I demur to a sentence in an otherwise admirable letter in the *Glasgow Herald* of this week. The writer says, "economists know better than any other class of men that, with the increasing labour-saving machinery that is being introduced, the industry that cannot afford its workers a moderate standard of comfort is one for the successful prosecution of which our conditions and circumstances are not adapted, and which must sooner or later decay." This is perfectly true; but what I want to bring out is the fact, that it is not a question between a wage that will afford its workers a moderate standard of comfort and one that will not, but between a wage that rises and falls with price and a wage that is fixed. In either case they may have a high standard of comfort: in the one case the miner would require to lay by in good times against the coming bad ones; in the other, he would have, perhaps, no surplus to lay by. On the whole, I am by no means sure that the employing classes would not have the best of the bargain, in being residuary rather than preference shareholders.

As corollary to all this, must be brought forward another issue that is necessarily involved in the settlement of this one. If the principle of a minimum wage be granted as regards the miners, I do not see how it can be limited to them, either on account of the severity and unpleasantness of their work, or on account of any pressure of competition on them that is more unfair than is the competition in other departments of industry. But, if extended to other trades, it will involve that only workers of a certain strength and ability are engaged, and that all under that standard are shut out from employment. If the problem of the unemployed is severe just now, I scarcely like to think what it would be under these circumstances.

The theoretical solution of the problem is, of course, to set the unemployed to work for each other. But if this could be done—and the difficulties are enormous,—it would divide the working classes into two great sections; those who could earn the minimum wage and upward, and those who had no minimum wage. That is to say, the burden would be lifted off one class of workers to rest on another. And this suggests the problem that is even now coming to the front as the most difficult of all—the relation of women's labour and wage to the labour and wage of men. There is already a well-marked tendency for women to extrude men from the trades in which men and women are working together. In the collieries this difficulty is absent, owing to the prohibition of women from underground employment, although I fear that it would be possible for boys and youths in the pits to undersell the minimum wage. But if the principle is extended to all trades, then, unless women also come under its operation, it will result in an immense extension of the field of women's labour. It is not too much to predict that, if men are forbidden to work unless they can earn 24s. a week, the wife will become the wage earner in many a household.

In concluding, let me say that I am quite aware that much which I have said seems heartless enough. I envy those who have no hesitation or misgiving about telling the people that every man who is able and willing to work has a *right* to a fair and reasonable wage. It is so easy to say so, and one is so sure of applause. But, as an economist, I must ask—How any man can have a *right* to a wage unless he produces something worth the

wage, and who is to decide whether his work is worth the wage or not but the people who buy what he makes? An artist would never claim that he was entitled to get a price for his pictures if nobody wanted them. How can the man who wields a pick claim to get a price for his work unless people want his coal?

I can perfectly understand and honour this appeal to "rights" in the mouth of the Socialist. If a man believes that the present organisation of industry has, wrongfully or mistakenly, given the power of employment to a few, in allowing the necessary instruments of production to get into private hands, he has some claim to demand that the State, which permits that monopoly, should give, at least, wages to those whom that monopoly excludes from work. But I cannot understand those who hate the name of Socialism, and yet hold up employers to obloquy, because, under the present competitive system, they will not guarantee a living wage to every one who is willing to enter their employment.

The statistics which I gave at the beginning of this paper show that, if the organisation of industry were perfect, there need be no wage so low as the living wage for any workman of average ability and steadiness. But the price we pay for highly organised and highly productive labour is—terrible hardship when the organisation goes wrong, or when the individual cannot find his particular place in that organisation.

V.—*On the Report of Lord Herschell's Committee on Indian Currency.* By ALEXANDER MACINDOE, C.A.

[Read before the Society, 29th November, 1893. A Communication from the Economic Science Section.]

MY first duty must be one of apology and explanation—apology for presuming to appear before an audience, many of whom must be far better acquainted with the subject than I can be. You will wonder what title I have to address you on the matter of Indian Currency. I am not a foreign merchant; I have no dealings with any foreign produce; and have no practical acquaintance with bills of exchange on India.

But this Indian currency question is not one entirely by itself. It is only one part of what for many years has been known to all commercial men as the Silver Question, of which there are three main divisions—namely, (1) American Silver Legislation; (2) Indian Currency; and (3) Bimetallism. These are all closely bound together, and no review of any one branch can be satisfactory which does not to some extent take cognisance of the others.

My first practical interest in the silver question arose during a visit paid to the United States in 1887. We were introduced by friends in Philadelphia to the Master of the Mint there. It was when he was explaining the differences between the American system and the British system of coinage that the importance of the American purchases of silver first became apparent to me, and the question arose as to which nation had adopted the better plan. Before I left the American shores I had formed the opinion that the American system was wrong, that the British system was right, and that the purchases of silver under the Bland Act must come to an end at no distant date.

You will remember the spring of 1890, when rumours began to reach this country from America of new silver legislation. At that time I entertained little doubt that this was what I had been

expecting—namely, the repeal of the Bland Act. To my surprise further news told us that, instead of the purchases of silver being stopped, they were to be doubled. To the last moment I did not believe that any sane and responsible government would ever pass the Sherman Bill. But it did pass; and then the most important matter was to look into the reasons which led the Americans to pass a bill which seemed to be so hopelessly wrong.

I do not propose to go into all the reasons which led the Americans to pass the Sherman Bill, but I will call your attention to the one which was widely circulated as the principal reason in every agricultural state: it was Indian competition.

Since 1881 the condition of the American farmer had not been very prosperous. Grain had been steadily falling in price, and that had resulted in losses or diminished profits to the farmers who grew it, and the railroads which carried it. All the American financial papers had for years been discussing this question, and, without exception, they all pointed to India as the competitor whose increasing exports of wheat swamped them in the markets of England; and they were never tired of pointing out how every drop in exchange was a practical bonus to Indian exporters. Every drop in exchange neutralised to the Indian farmer the drop in the Liverpool price of wheat. With wheat at 30s. a quarter, the Indian farmer would receive as many rupees as with wheat at 40s., if exchange dropped proportionately, while to the American farmer this drop in wheat was total loss. The argument was, therefore, put in this way to the American agricultural states: India is your competitor owing to the practical bonus given by the low exchange. If the American Government buys silver that will raise the price of silver, that will drag up the Eastern exchange, and that will choke off the bonus which enables your Indian competitor to damage you. From this you will see that the American view of the question was that a low exchange was an immense advantage to Indian producers and exporters.

But when we turn from the American aspect of the question to the views expressed in Lancashire papers, letters to the Glasgow papers, &c., we find that a different opinion prevails. The fall in exchange is there said to be hampering trade, damaging Manchester, and ruining India itself. Both of these views could not well be true, and it was in an endeavour impartially to discover where the truth really lay that my interest in this Indian currency question was first aroused.

With these preliminary remarks, I now come to the Report itself. I do not propose to go over in detail the 157 paragraphs, because all of you will have read the document itself, and the conclusions of the Report can be very briefly stated. You will all be aware that the practical results of the Committee's recommendations were :—

1st. That the Indian mints were to be closed to the free coinage of silver.

2nd. That the Government were to sell rupees in exchange for gold at the fixed ratio of 1s. 4d.

3rd. These two steps were to be preparatory to the adoption of a gold standard.

The question of all-overshadowing importance *now* is, not whether India should have had a gold standard or a silver standard, not whether the difficulties of the Government were really so serious as some imagine, and the claims of the civil servants so pressing; but the question is, whether the scheme which *has* been fixed upon will eventuate in getting them a gold standard, or whether it will be ineffective; whether, in short, it will lead them to success or will land them in disaster.

Now we are not met here to-night to discuss bimetallism; but I fear that my criticism of this scheme would not be intelligible unless I indicated to you from what standpoint I looked at it, whether from the monometallic or the bimetallic standpoint. Therefore I shall briefly state my creed on that matter. I believe that there are some things a government can do, and some things that no government can do. A government can fix weights and measures. No government on earth can fix a price of any thing. It is the duty of the government to fix the length of the yard-stick, the capacity of the bushel, the weight of the ton, and the *weight* of the rupee and of the sovereign. A government can no more fix the price of the 180 grains of silver in the rupee, or the 123 grains of gold in the sovereign, than they can fix the price of the pig-iron in the ton, or the wheat in the bushel, or the cloth in the yard.

On the first announcement of this scheme, Mr. Donald Graham is reported to have stated to an interviewer of the *Evening Citizen* that this was a serious blow to bimetallism. No doubt, to a certain extent this was true, in so far as it was a further demonetisation of silver; but, on the other hand, it seemed to me

that it was an immense concession to bimetallism, in so far as it fixed a ratio. A monometallist says, you cannot fix a ratio, but these Commissioners have done it. They have decreed that the rupee shall be worth 1s. 4d., and that a seller of gold shall take the rupee at 1s. 4d. or shall want it. The first question now is, What is that decree worth?

On the day that the Report was issued, silver was quoted at about 30d., and the metallic value of the rupee, therefore, was under 1s. The Committee have fixed it at 1s. 4d., that is to say, 30 per cent. above its intrinsic value, and I shall now proceed to examine the reasons which led the Commissioners to think that such a price could be fixed and maintained. It seems to me that, on the very face of it, this measure appears an impossibility, and that very powerful reasoning would be required to satisfy any business man that such an apparent impossibility would be a practicable measure.

Paragraph 66 (on page 20) of the Report reads, "The first objection taken to the scheme is that it would not be practicable to maintain the rupee in the manner suggested, on a ratio to gold much higher than that of the intrinsic value of the silver of which it consists. We have already alluded to the reliance placed by the Government of India upon the phenomena exhibited in the currency system of France and other nations." Paragraph 50 (page 17) reads, "He (Sir David Barbour) refers to the example of France and other nations as showing that it is possible to have a gold standard though a large percentage of the circulation consists of over-valued silver coins which are legal tender to any amount."

You will see that there is not a line there of positive argument that the scheme is practicable. They simply say France can do it, and other nations.

That seems far from satisfactory reasoning. A scheme of such magnitude should surely be supported by some strong positive argument demonstrating its practicability, instead of by a mere reference to supposed analogies. However, we must deal with such arguments as the Commissioners give us. Let us look, then, at the case of France, which is held up as an example to India of the practicability of maintaining legal tender silver above its intrinsic value.

Paragraph 82 (page 23) reads, "The peculiarity of the French currency is the large amount of five-franc pieces which circulate

at the old ratio of 15½ to 1. They are legal tender to any amount, and are accepted as freely as the gold coin. . . . The stock of currency appears to be as follows:—

Gold (about), - - -	£171,000,000
Silver, - - - -	140,000,000
Notes, - - - -	132,000,000

* * * * * * *

There is no difficulty in maintaining either the silver or the notes at their gold value."

Paragraph 83 says, "Here is a currency which, for all practical purposes, appears to be perfectly sound and satisfactory, but which differs from our own in most important particulars. . . . The standard is really gold, whilst a very large proportion of the currency is either inconvertible silver or notes, payable at the option of the bank in silver or gold, maintained without difficulty at the above-mentioned artificial ratio."

You see the argument. France has £140,000,000 of silver which is maintained without difficulty at the artificial ratio of 15½ to 1. If these facts were correct, the argument might have some weight, but what is the real state of the case?

In the month of January of this year a curious announcement appeared in the papers that the Bank of France was going to buy no more gold. At that time the export of gold from the United States was seriously alarming our American friends, and this announcement put them in immense good humour. Now their gold exports would stop. They sang hymns of joy, and wrote articles saying that Europe was getting surfeited with gold. Alas! the joy was short-lived. They soon found out that the Bank of France was not surfeited with gold, but so choked up with silver that she had to apply to Government for an enlargement of her charter to enable her to conduct her business. I shall now show you how the Bank of France got thus choked up with silver. As the Commissioners tell you, silver in France is legal tender to any extent at the ratio of 15½ to 1; that is to say, the Government and their agent, the Bank of France, have undertaken to fix a ratio, and to keep at that par the £140,000,000 of silver. In order to fulfil this obligation to maintain that silver at par, what have they had to do? The Bank of France has been compelled to lift out of the market, and lock away in its vaults, the enormous sum of £51,000,000, more than one-third of the whole amount. That

silver they had to pay for with gold, and its cost, of course, was £51,000,000. They did not want one penny of it. It was shovelled in upon them. To-day it is worth about £29,000,000. So that upon that transaction they have lost about £22,000,000.

That is the cost of maintaining a ratio. But that is not nearly all. The Bank of France holds in gold £67,000,000. This enormous amount of gold is held for two purposes :—

1st. For their ordinary banking business.

2nd. For the purpose of keeping up public confidence in their ability to maintain the ratio of 15½ to 1 on that £140,000,000 of silver.

Now, opinions may differ as to how much is necessary for the one purpose, and how much for the other. The Bank of England conducts all its business with about £25,000,000 of gold; the Bank of Germany has only £30,000,000, and it has £20,000,000 silver thalers to keep at par. The matter is one of opinion, but most competent authorities say that, at the lowest estimate, £30,000,000 of gold is held by the Bank of France, for the sole purpose of keeping the silver at the fixed ratio. To fulfil this obligation to maintain a ratio, the Bank of France thus holds, of useless metal, £51,000,000 of silver and £30,000,000 of gold—together, say, £80,000,000. Interest on that sum, at, say, 3 per cent. = £2,400,000. That is to say, the cost to France of this bimetallic ratio has been—capital lost, £22,000,000; annual interest charge, £2,400,000 sterling. This annual charge has gone on for many years, and will go on for ever, or till France drops her remnants of bimetallism.

This is the example which Sir David Barbour and Lord Herschell's Commissioners hold up to India. I ask you—Do you think the Commissioners are right when they say, in paragraph 83, that silver is "maintained without difficulty at the above-mentioned artificial ratio"?

I hope I have made this matter plain. It is one that is not very well understood in this country. Ill-informed writers have long been in the habit of pointing to this enormous mass of metal in the Bank of France as a *war* chest. It is only of late years that the true state of matters has been pointed out by experts and is getting more widely known. The Bank of France is engaged in a war, but it is not against the Germans. It is fighting against the *laws* of nature.

The Commissioners then proceed to examine the case of Austria. In paragraph 90 (page 25) they give a table showing in parallel columns the Vienna exchange on London and the price of silver, and they say, "The whole oscillation between 1879, when the mints were closed, down to 1891, when the resolution to adopt a gold standard was taken, was less than 9 per cent., and at the end of the period it stood at nearly the same figure as at the beginning, though in the meantime the price of silver had fallen by nearly 12 per cent." They go on to say, paragraph 91, "This is a very remarkable case. The fall in exchange, which would have accompanied or followed the fall in the market value of silver, has been averted by the closing of the mints. Fair steadiness of exchange has been maintained for more than a decade, although the paper currency was inconvertible, and silver was coined on Government account alone."

That certainly would be a most remarkable case, if it was correct. But what are the facts of the case? Austrian currency has been from time immemorial inconvertible paper. In a country with inconvertible paper, exchange fluctuates, not with the price of the metal at all, but with the credit of the Government. In Argentina they have inconvertible paper based on gold; in Brazil inconvertible paper based on silver. In these countries exchange jumps about between 200 and 300 premium, not because the metals fluctuate, but because the credit of the Government is looking better or worse. So it was in Austria. I have prepared a table giving the price of Austrian Government stocks from 1879 onwards, showing that Austrian credit was improving, slowly but gradually. (This table has not been printed, but briefly it may be stated that Austrian Silver 5 per cent. Rentes rose steadily from 57 in 1879 to 80 in 1892, while in the same period Austrian Gold 4 per cent. Rentes rose from 69 to 95). That was the influence that steadied exchange—namely, the rise in the price of the Government stocks and the improvement of their credit; and the closing of the mint had not one jot of influence on the price of exchange.

For the purposes of the proof which the Commissioners wish the foregoing example of Austria is absolutely inconclusive, and their arguments are unsound.

Great importance is attached by some persons to the case of Java, and lengthy evidence was taken by the Commissioners on the system of Holland and the Dutch East Indies. The Com-

missioners seem to think the system there works well, and they report in paragraph 89, "The silver is kept at an artificial ratio much higher than its market value, although neither it nor the paper is convertible into gold, except for the purposes of export. This artificial exchange is maintained in the Dutch East Indies where there is little or no gold."

But between the case of Java and that of India there are differences which prevent absolutely any reliable comparisons being made.

The silver of Java is unlimited legal tender in Holland. When the rupee is made unlimited legal tender in Britain, there will be some similarity between the two cases. Till that is done, there is no connection between them, and the comparisons made by the Commissioners in the above-quoted paragraph seem of no value.

The main positive argument running through the whole Report is that, by closing the mints, a limit will be placed upon the number of rupees. That will make them scarce, and they will then rise in value to the fixed ratio of 1s. 4d. That argument you will find in paragraph 50 (page 17) of the Report; also on page 148, paragraphs 2 and 10, of the Minutes of Evidence. Not a doubt of the correctness of this argument ever seems to have occurred to the Commissioners. In their Report they do not argue one word in support of it. They simply assume its correctness. To show that this is Sir David Barbour's belief, I shall read you a few lines from the evidence of his henchman, J. L. Mackay, who is being examined in favour of the scheme:—

"Question 1216.—The proposal now is that the Government shall exercise a control over the quantity of rupees in currency in India?—Yes.

"Question 1217.—Does not the value of the rupee depend upon the quantity which is in existence in India. If they become too few for the wants of the country, the rupee will rise in value.—Yes.

"Question 1218.—Consequently, if the Government have the power of fixing the quantity of rupees in India, they have the power of fixing the price which they shall get for their own Council Bills in London?—Undoubtedly."

These questions—1217 and 1218—are the keynote of Lord Herschell's whole scheme. The correctness of their theory they never doubt. It seems perfectly obvious to them that, if the mints stop work, rupees will become scarce, and will rise in value.

Two questions at once present themselves for consideration :—

1st. Is it possible that any artificial scarcity can ever permanently raise a price?

2nd. Is it possible that the closing of a mint can have any effect at all on metal coined or uncoined?

To the first question I should without hesitation reply that no artificial scarcity will ever permanently raise a price. No doubt, prices will rise if a real and natural scarcity takes place. That would be the law of demand exceeding supply, but I never heard of an *artificial* scarcity raising prices permanently. This principle of artificial scarcity is the principle on which speculators engineer "corners" in wheat, cotton, pig-iron, &c., but the makers of a "corner" never mean permanently to keep up prices. Their only aim is to keep up a price for a very limited period. The idea that an artificial scarcity can permanently keep up a price seems to me at variance with common-sense.

But it may be said that this attempt of the Indian Government to fix a price is more analogous, not to "corners" but to combinations by capitalists. Now, I am fairly familiar with most of the combinations by capitalists of recent years, and I can only say that, as far as I am aware, every one of them has, sooner or later, come to an untimely end, and that most of them have landed their promoters in disaster. The most famous of all modern attempts to control prices was that of the copper syndicate. It began with every element of success. It controlled the supplies of every copper mine in the world. It had command of unlimited finance. It was backed by the Rothschilds of Paris, the Comptoir d'Escompte de Paris, the greatest bank in France, and was directed by the ablest business men of the day. They raised the price of copper to £80, and they kept it there for many months, and those who had to buy copper had to pay the price. But the world knew that the scarcity of copper was artificial, and no new enterprises requiring copper were entered into. From the day the price was raised the demand fell off, the copper accumulated, and the laws of nature swamped the men who made the artificial scarcity.

That is practically the history of all combinations or attempts to fix a price, and it is, I suspect, the coming fate of the Indian Government. They have whipped up the price of rupees to 25 per cent. above their real value. The world knows that the price is unreal, consequently the demand will fall off, and the supply of

Council bills goes on accumulating in London. They certainly may sell a portion of their requirements at the fixed price, but I cannot think that they will ever sell enough, and the laws of nature, which swamped the American Government and the copper syndicate, will not spare them.

Is it possible that the closing of the mints can have any effect at all, or can prevent the disaster I have predicted above? In paragraph 65 (page 20) the Commissioners say, "It is impossible to estimate the extent to which the rupee might be raised if the Indian mints and Indian currency were to remain closed against both precious metals." To estimate the effect of the closing of a mint, we must consider what a mint is. In early times all bargains were made in weighed metal. A rich nation would make its bargains in one metal, and a poor one in another. When it became obvious in what metal the majority of the individuals of a nation were making their bargains, the government stepped in and offered to assist the traders by helping them to weigh the metal, and by certifying the weights. A mint is a mere weighing establishment; it neither buys nor sells, it fixes no price. You take your lump of gold to the London Mint, say, 40 lbs., you wait till they weigh it for you, and they hand you back, theoretically, your identical 40 lbs. of gold, weighed into 1,869 equal pieces called sovereigns. That is the provision of the Coinage Act of 1816—namely, that 40 lbs. of gold shall be weighed into 1,869 sovereigns. Seeing that 40 lbs. of gold is split up into 1,869 sovereigns, simple arithmetic tells us that one ounce of gold will be split up into three sovereigns, with some small change over—namely, 17s. 10½d. But, as this weighing and splitting up transaction cannot be very briefly and scientifically put into words, the popular way is to say that the mint price of gold is £3 17s. 10½d. Of course, this popular expression is scientifically just as inaccurate as the expression that the sun rises and sets. The phrase, "the mint *price* of gold," is perfectly misleading, and should never be used in any scientific discussion. A coin is a *weight* of metal—nothing else.

I wish to emphasise this point, because it seems to me that three-fourths of the delusions under which people labour about currency are due to the idea that the mint is a market or price-making contrivance, instead of a mere weighing and stamping establishment.

Similarly, in India you take your bar of silver, say, 1,000 tolahs,

to one of the Indian mints, and you wait till they weigh it, and they hand you back your identical silver weighed into 1,000 equal pieces called rupees.

With these facts in view, the question is—If the Government close this weighing house, will that have any effect upon the price of silver already weighed—that is to say, rupees; or on the price of silver not weighed—that is to say, bullion? There is no difficulty or mystery about weighing metals; any one can do it. At the present day, in many inland bazaars of India, bargains are made in weighed silver, and a pair of bullion scales are as common as cloth measures. For years also the banks regularly have acted as mints, and have been importing bars of silver with their weight stamped on them—1,000 oz. or 1,200 oz. These pass current for their weight in rupees. Since the closing of the Government weighing houses or mints, the natives have been importing these weighed and stamped bars in greater quantity than ever before. The use of coined rupees can thus, it will be seen, be dispensed with almost entirely, except, perhaps, for the payment of taxes. As late as the year 1529, when the Scotch Government threatened to play pranks with the coins, our forefathers began to make bargains in weighed ounces of silver. It seems to me certain that the wily natives of India will contrive to dispense with coins rather than pay to the treasury one gold sovereign to get 15 rupees when they know they should be getting 19 or 20. I hold in my hand that famous book, the charter of our British coinage, "Lord Liverpool's Coins of the Realm." Lord Liverpool quotes with approval John Locke's opinion, "One ounce of silver, whether in pence, groats, or crown pieces, stivers, or ducatoons, or in bullion, is, and always eternally will be, of equal value to any other ounce of silver under what stamp or denomination soever." I adhere to that doctrine, and I shall now add the conclusion to which I have come—namely, that the closing of the Indian weighing houses or mints will have no more permanent effect upon the price of rupees or silver bullion than the abolition of the ton weight would have on the price of pig-iron, or the abolition of the mutchkin stoup on the price of Scotch whisky.

Returning, then, to Question 1217, "Does not the value of the rupee depend upon the quantity which is in existence in India? If they become too few for the wants of the country, the rupee will rise in value?"—J. L. Mackay answers, "Yes." I disagree with

that, and answer "Certainly not." You may make them artificially as scarce as you like, and you may cause immense inconvenience to traders, but no artificial scarcity will raise their purchasing power above their metallic value. Let me read three answers of Thomas Jackson, Manager of the Hong Kong and Shanghai Bank:—

"2002.—Are you not going to raise the purchasing value of the rupee?—I do not think you can do it.

"2003.—But you are going to do it supposing the changed ratio is adopted? . . . I do not think it would have any effect.

"2005.—Then you do not think that it would be possible, by adopting the gold standard, to raise the purchasing value of the rupee?—I do not think so."

I entirely agree with every word that Mr. Jackson says. The Commissioners are attempting what seems to me an absolute impossibility. The idea which they express in paragraph 65, that "it is impossible to estimate the extent to which the rupee might be raised," is a lamentable commentary on the value of their commercial opinions.

On this point we are not without some experience of the effect of a scarcity of currency. During the late American crisis, in July last, currency was very scarce in the States. There was a premium on gold coins, and on silver coins, and even on paper notes. But the scarcity of them did not affect or increase by one cent their power to buy British sovereigns. I was in Italy last spring; there the scarcity of coins was almost ludicrous. But the scarcity of their rubbishy coins conferred on them no extra buying power whatever. The only effect of a scarcity of coins is vast inconvenience to traders.

Just before I pass from this point will you allow me to read a few lines from Lord Macaulay? He is describing the great recoinage of 1695, and is dealing with the then Secretary of the Treasury, a currency monger, whose schemes were ruthlessly upset by the practical authors of our present system of coinage, Sir Isaac Newton and John Locke. The passage, though written 200 years ago, perfectly applies to the present state of matters, if the names of the persons and the coins are changed:—

"At the head of this party was Wm. Lowndes, Secretary of the Treasury, a most respectable and industrious public servant, but

much more versed in the details of his office than in the higher parts of political philosophy. He was not in the least aware that a piece of metal with the king's head on it was a commodity of which the price was governed by the same laws which govern the price of a piece of metal fashioned into a spoon or a buckle, and that it was no more in the power of Parliament to make the kingdom richer by calling a crown a pound than to make the kingdom larger by calling a furlong a mile. He seriously believed, incredible as it may seem, that if the ounce of silver was divided into seven shillings instead of five, foreign nations would sell us their wines and their silks for a smaller number of ounces. He had a considerable following, composed partly of dull men, who really believed what he told them, and partly of shrewd men, who were perfectly willing to be authorised by law to pay £100 with £80."

I wonder if it has ever occurred to Sir David Barbour that it is no more in his power to make India richer by calling one shilling 1s. 4d. than to make India larger by calling a furlong a mile.

From these observations you will see that my opinion is that this scheme is wrong in theory, and cannot be carried to a successful conclusion. I shall now endeavour to show how practically the scheme is leading the Government of India into disaster.

India is a debtor country—that is to say, her Government owes money to foreign countries. She has got to remit large sums of money annually to London. For the year 1892-93 the state of her foreign trade was as under:—Her exports exceeded her imports by about Rx. 36,000,000. This was squared by her importing bullion for Rx. 11,000,000, and selling Council Bills for Rx. 25,000,000. For the year ending March, 1894, India has to remit to London about £18,500,000. That is to say, she is a compulsory seller of Council Bills for about Rx. 24,000,000. She can only sell these Council Bills provided the favourable trade balance exists—that is to say, provided her exports exceed her imports by about Rx. 24,000,000. To every debtor country her exports are her life blood; without them she cannot pay her foreign indebtedness. Her imports may be the important thing to other countries trading with her, but they are not so to the debtor nation itself.

It was, therefore, of paramount importance to India that nothing should be done to diminish her favourable trade balance. In the first part of this paper I mentioned that the Americans were

convinced that the low exchange was a bounty on Indian exports. They were not alone in that opinion. Every practical witness warned Lord Herschell that any raising of exchange would diminish or tend to diminish Indian exports, would tend to increase her imports, and would thus destroy her favourable trade balance. In Question 1499 Mr. Stephen Ralli is asked—"Do you think that the decline in silver has increased production in India?" and he replied, "I do not think there can be two opinions on this point; that is an evident thing. No man who has any practical experience of India and of the export trade can have any doubt whatever that the decline in silver and the decline in exchange have materially conduced to the great development of the export trade."

The manager of the Hong Kong and Shanghai Bank also made some caustic observations on the point. "Question 1994.—Do you think that that (raising exchange to 1s. 6d.) would affect the amount of trade between India, China, and other silver countries of the east?—That is absolutely certain. It is not a question to think about at all. It is absolutely certain."

But the Commissioners did not believe that. The Gold and Silver Commission doubted it; so does this Commission. Hear what they say, paragraph 121 (page 32), "It is further objected that the balance of trade would be disturbed, that the export trade of India would be injured by a gold standard, and that India would then *pro tanto* lose her power of paying her debts, and that the Indian Government would, in consequence, be unable to sell their bills in London. This objection seems to depend on the question whether the export trade of India will be injured by the proposals of the Government with which we have dealt in paragraph 27." That paragraph is headed, "Alleged stimulation of exports by fall in exchange," in which they prove, to their own satisfaction, that the theory is untenable, and they conclude with the words, "Upon the whole we cannot see any evidence that the effect of a falling exchange in the country at large in influencing either exports or imports has over a series of years been very considerable." In paragraph 116 they amplify that sapient opinion, and add that they "examined the trade statistics of India, and could not see any evidence that a relation existed between a fall in exchange and the volume of exports."

Now look at the facts. Since the closing of the mints the Accounts of the Foreign Trade of India have been published for

the months of July and August. (See the *Economist.*) They show as follows :—

	1892.	1893.		Differences.
Imports, ...	Rx. 12,112,900	Rx. 14,236,700	+	Rx. 2,123,800
Exports, ...	14,709,300	13,233,800	—	1,475,500
In favour of India,	Rx. 2,596,400			
Against India,		Rx. 1,002,900		Rx. 3,599,300

That is to say, in the two months since the closing of the mints, India's favourable trade balance has been injured Rx. 3,599,000. If that goes on, it is obvious that in twelve months Rx. 22,008,000 will be wiped out. No wonder that the Council have been unable to sell almost any bills since the day they closed the mints. I confess that I do not think they ever will sell many bills. They may certainly sell some during the export season, but I cannot see how they will ever sell enough. Their experience will be that of the copper syndicate, and of all syndicates and combinations who whip up prices artificially. They choke off buyers; supplies accumulate, and that swamps them. My impression is that it is now only a question of time till this scheme lands the Goverment of India in wild disaster.

A question of importance is the justice to the natives of India of this artificial raising of the price of the rupee. Every debtor in India finds his debt raised 25 per cent. The land tax, which is a rent for a fixed period of years, is raised 25 per cent. The rent of every dwelling-house, every farm, every office, is raised, and simultaneously, as exports get choked off, the produce of every garden, every farm, begins to fall.

But the greatest injustice arises in connection with the hoards of silver bullion. Hoarding in India is carried on to an extent unknown to western civilisation. These hoards consist principally, not in minted rupees, but in bullion. When a native saves a few rupees he melts them into bullion, or makes them up into bracelets, bangles, and other ornaments. In many inland bazaars trade is carried on, not in rupees, but with weighed silver. When a native buys cloth, he hands over to the merchant a bangle, which the merchant weighs, and counts accordingly. These bracelets, bangles, and bullion, have hitherto been considered as good as gold, because the natives knew that they had only to send them to the mint and they would be coined for them, grain for grain,

into rupees. Consider, then, the feelings of the natives when they learn that these silver hoardings will no longer be taken from them in payment of their purchases, and that the action of their own Government has knocked 25 to 30 per cent. off the value of their savings.

On this point of the justice to the natives, almost nothing is said in this report, but a paragraph in the Report of the Gold and Silver Commissionsheds a curious light on Lord Herschell's views. In that report he says that all monetary bargains are entered into, subject to such alterations in the currency as the government may think fit for public weal, and that the natives of every land must be liable to such inconveniences. That may be English law, but is it common fairness? I should say, on the contrary, that all bargains are entered into on the understanding that the government will *not* "jerrymander" the currency. Alterations in currency have always been recognised as unjust. So much so, that our Scottish Parliament, sitting in Edinburgh in 1495, passed an Act providing that, when the Government altered the value of the coins, old bargains made were to be implemented with coins of the weight and value which they possessed before the alteration. That seems to me to be common sense and common fairness.

But it may be argued that this is not an attempt to fix a ratio, but simply an attempt to change from a silver coinage to a gold coinage. Other nations have done that before without any injustice. The United States, after the Civil War, resumed specie payment; Germany, after the war of 1871, changed from silver to gold; Austria has recently changed her currency. But mark the essential difference between these cases and the case of India. These countries each gave years of warning, and they fixed no ratio. They allowed the laws of nature to fix the ratio—that is to say, the market price of the day,—and they simply adopted the ratio which the laws of nature fixed. What did the Indian Government do? They gave no warning, and they fixed a ratio 30 per cent. above the market price.

If a German or Austrian debtor thought he was being wronged by the change, he had ample time to pay his debts in the metal in which he contracted them, or to make a new bargain. The Indian debtor did not get one moment's warning. He might have heaps of silver bullion lying beside him to discharge his debts. One day this was available grain for grain. The next day he was told that this was useless, and that he must go to the mint and there

buy rupees at 30 per cent. above their value, paying for them in gold.

In paragraph 29 the Commissioners deal with the question of the attraction of an open mint for depreciating silver. I mention this because some Glasgow pamphleteers are very strong on this point, that India is being flooded with cheap silver, owing to the mint being a market. This opinion arises entirely from the mistaken idea of the real nature of a mint. By its very nature it can have no power to attract metals. It follows them. A hundred years ago Adam Smith gave the reasons why silver went to India and the east. It goes there for these reasons still, and it will continue to go there, whether the Government will weigh it for them or not, and in spite of any other helpless attempts the Government may make to keep it out, by imposing import duties or such like.

In discussing what would be the proper remedy for Indian matters, a preliminary question arises for the consideration of impartial persons — namely, Should India be governed in the interest of her 280 millions of inhabitants, or in the interest of her rulers, her civil servants, and the foreign merchants? There can be little doubt that the present agitation has been largely got up by the 3,000 civil servants in India and some ill-informed foreign merchants, acting, of course, on Sir David Barbour. Remember that India has of late years been very prosperous, that she is a lightly taxed country, and that, for the last ten years, she has had an average annual budget surplus of Rx. 261,500. In the most famous letter that Lord Sherbrooke ever wrote, he said that persons who were to benefit by any financial measure were the very worst judges of its expediency. That seems obvious. But this Commission was appointed largely owing to the agitation of those who had direct personal advantage to gain. For example, on page 301 you will find a letter from a well-known Glasgow merchant, addressed to Sir Archibald Orr Ewing:—"We have to-day, for the first time, a remittance from Calcutta under 18d., which brings strongly before me the need for contriving something that may correct the constant fall"—the contrivance, of course, being Government interference. That letter is quite frank. It does not profess to be written in the interest of anyone but the writer. A few weeks ago the exporters from Argentina, when the gold premium dropped some 20 points, petitioned the Government to try and stop the

fall in gold. It suited them to have it high. They did not consider the importers, or the natives, or the Government. They thought of no interests but their own. Is the position of the writer of that letter materially different from that of these simple-minded Argentine exporters?

What many consider the proper remedy for Indian difficulties was alluded to by Mr. Stephen Ralli and Mr. John Beith—namely, a tax on imports into India. That remedy, well-informed authorities say, should be adopted, and would be adopted by India if her hands were free, and would be approved of by the Home Government if they professed to rule India in the interests of her own inhabitants; but, meantime, as Mr. Beith said, public opinion here would not permit that—a step which would seem detrimental to Lancashire, though beneficial to India.

In my opinion the Commissioners have erred in several important points:—

1. Being tinged with bimetallism, they have under-rated the difficulty (I say the impossibility) of fixing a ratio.
2. They have under-rated the enormous effect of a low exchange in stimulating exports, checking imports, and thus producing a favourable trade balance.
3. They have overlooked the difference between a country with no foreign debt, like France or Java, and a country with an enormous foreign debt, like India, which has to buy £18,000,000 of sovereigns yearly in London.
4. They have overlooked the difference between a rich country, like France, and a poor country, like India. France can afford to lock up £80,000,000 of metal. To India that would be impossible.
5. They have failed to observe what a mint really is—namely, a weighing and stamping establishment, and have consequently over-estimated the effects of the mere closing of the mints.

In the whole history of commerce there is nothing more ludicrous than the attempts by government to fix prices. What have they not tried. Henry III. fixed the price of bread and ale. Edward III. fixed the price of wages and wheat. In 1766 the French Government fixed the price of money at 4 per cent., but it continued to be lent at 5 per cent. They fixed the price of the assignats

at 100, and decreed the penalty of death against those who would not take them at that, but they fell to nothing. During England's 400 years of bimetallism over 20 different ratios were fixed. Not one of them would last. Finally, the exploits of the guinea, which defied all their efforts to value it, convinced Lord Liverpool of the hopelessness of trying to fix a price, and drove the British Government to adopt our present system, which is one of simply weighing the gold,—the most beautiful and most perfect system the world has ever seen. But after Britain abandoned the hopeless attempt, France continued to fix a ratio, and I have shown you what that has cost her. In 1870 the Canadian Government decreed that the American dollar should pass current in Canada for *80* cents, but from that day to this it has passed current for *100*. Then, in 1890, the Americans passed the Sherman Bill, and boasted that with that they would peg silver at 59d., but it never went near there, and that attempt to fix a price brought the richest treasury in the world within a few days of bankruptcy. In all history there is not a record of one single successful attempt to fix a price. Every attempt that I know of has ended in failure, and to the list of past failures there will soon have to be added, I fear, the present attempt of the Indian Government to fix the rupee at 1s. 4d., or at anything above its metallic value.

VI. — *On the "Paristagan" System of Building with Concrete.* By John Dougan, Whit. Sch., Consulting Engineer.

[Read before the Society, 13th December, 1893.]

(Plates I. and II.)

Some time ago I was asked in my practice, as a consulting engineer in Glasgow, to design cheap dwelling-houses in iron, such as corrugated sheet iron, with a wood lining inside. I gave corrugated sheet iron, even enamelled sheet iron, such a bad character that the idea was abandoned. The faults which I had to find with corrugated sheet iron were—its comparative short life, bad weathering properties, great conductivity for heat and sound, annoyance due to falling rain, condensation of moisture inside, which rendered houses made with it almost uninhabitable. Then there were the oppressive heat in the summer and cold in the winter, as well as the inartistic appearance of the material. Where the corrugated sheet iron is lined with wood inside, in the form used in small hospitals, the joints of the wood are more or less open. There is also danger from fire. The wood cannot be disinfected, but will absorb more or less of the products of respiration, along with the germs of disease.

Having condemned one structural material, I had to find another as good, if not even a better one. I turned my attention to concrete, and the first thing that struck me as being very odd about it was that it was used one way, yet tested in a totally different way.

The usual mode of making cement mortar or concrete is to mix the solid materials with a quantity of water, and then "dump" it into the trench, to form the foundation of a building, or into a temporary frame of boarding to make an ordinary concrete wall. That is wrong, decidedly wrong, and the chances are, more especially if there be a deficiency of water, that the concrete will be friable and go to pieces. For example, take a small quantity of cement, and mix it with as little water as possible, and place it on a piece of glass to dry; in a short time it will not take on the impression of the finger; but place a few drops of

water on it, and they will be immediately absorbed. Why is this?

Dry substances, like lime, cement, and silicate of alumina, act very little on each other, if at all, until the solvent power of water is employed to bring them into close and intimate contact. On the addition of water to any cement, a chemical change very soon begins, and goes on slowly during solidification. The water will constantly transfer the lime which it has dissolved to the siliceous particles which were combined with the alkalies; the newly-formed silicate of lime partially decomposes the other silicates of alumina and iron in the act of hydration, forming double hydrated silicates, which are practically insoluble. The water will then dissolve fresh lime, which is again employed in the production of more double hydrated silicates of lime and alumina,—and so on, till the molecular rearrangement is completed.

Mr. H. Faija describes, in Vol. LXVII. of the *Proceedings* of the Institution of Civil Engineers, the results of a large number of experiments on "gauging" cement with salt water, and afterwards exposing it to the air. The net results of his experiments are that in three months the tensile strength was increased 31·6 per cent. (664-874 lbs.); and in six months, when ordinary Portland cement has reached its maximum strength, 8·7 per cent. (848-932 lbs.) increase over the same cement tested in the ordinary way; in nine months, 27 per cent. (843-1070 lbs.); and in twelve months, 33·3 per cent. (840-1120 lbs.)

What is there in salt water that it should have such an effect on cement and produce so great an increase in strength? Salt water is just a strong solution of chloride of sodium, with a small proportion of chloride of magnesium, together with traces of other salts. Now, the only chemical change that could take place is that the chlorine, in combination with the sodium in the salt water, goes to combine potentially with the calcium or aluminium in the cement; but the chlorides of magnesium, calcium, and aluminium are all deliquescent, and will, therefore, absorb moisture from the atmosphere. This, no doubt, delays the "setting" of the cement; and it is almost a chemical axiom that the longer a substance is in crystallising the larger and harder are the resulting crystals. As well as being more perfect, they are also more durable and difficult to redissolve; and it is the same with slow precipitation, which allows of the complete rearrangement of the molecules, or the induration of the whole body of concrete.

Mr. W. Dyce Cay, C.E., who used about 15,000 tons of cement at Aberdeen Harbour Works, shows, in a table in Volume LXII. of the *Proceedings* of the Institution of Civil Engineers, the great increase of strength from the use of salt water. Mr. E. A. Bernays, in building the extension of the Royal Dockyard at Chatham, says that it is a good thing that the work as it proceeded was covered by the water at every tide. Even the quantity of water used in mixing cement is important, for, paradoxical as it may appear, if an insufficient quantity of water is used, the volume of cement is increased, in some cases as much as ten per cent., and, of course, the result is a porous cement, which no amount of pressure will make thoroughly solid.

Carbonic anhydride (CO_2) does not play a very important part in the setting of cement; it acts adversely, I think, in the absence of water, from its tendency to form carbonates, displacing the silicic acid in combination, and forming separated silica (SiO_2) and carbonate of calcium, which are only inert compounds. On the other hand, if water is constantly present, the carbonic anhydride does not reach the cement till it has been dissolved in the water, though the amount of the anhydride must be very small, but, being in solution, it is not so ready to separate out the silica. In considering this matter, look at some old lime mortars. It is said that carbonic anhydride only penetrates about one-tenth of an inch into an ordinary joint in the first year, forming a skin or film which prevents the further absorption of the anhydride, leaving pure, soft lime in the middle of the mortar (in some cases over 100 years old), with a slight coating of carbonate of lime on the outside, the rest of the mortar forming a soft, friable mass, just like sand. I have seen soft lime like this taken out of a slabbed tile hearth which had been in constant use for over twenty years.

Having found out the best way of treating the cement, and the rationale of the induration and setting of the whole, so as to produce an impervious concrete which water or moisture could not penetrate, I proceeded to use a natural, slow-setting cement—any good cement will do—which gives a tensile strength, on an average, of about 300 lbs. per square inch. It is first well mixed with three parts by bulk of well-burnt, hard coke breeze, and the requisite quantity of water added. Next, it is moulded into plates 30 inches by 18 inches, by $\frac{7}{8}$ inch thick, and subjected to hydraulic pressure to about 300 lbs. per square inch. The plates

are left in the moulds for a day or two, or until they are strong enough to be taken out, placed in a tank of water, or solution of silicate of soda, for a week or ten days, and afterwards exposed to the weather for a month to indurate—the longer the better; and if the weather is very dry, they are watered frequently.

If there is any weakness in the plates, from the use of bad cement, they almost invariably give way in the tank. The exposure to the atmosphere is to allow the induration to take place slowly, and so increase the strength and hardness.

In some cases, where the plates are wanted to be extra strong, they are made thicker, and a piece of coarse wire netting is placed in the middle of the plate when it is being moulded. This wire netting does not strengthen the plates very much; but in the event of the plate being fractured by great violence when in its place, the pieces are still held together, and can be easily repaired by means of "neat" cement, without removing or displacing anything.

In the operation of pressing the plates, if the temperature is very much lowered during compression, there is a tendency for them to get laminated. The resulting lamination is very marked at low temperatures, or in plates left under pressure during frost, showing, I think, that the molecular motion is at right angles to the pressure. It is almost needless to say that the plates should not be made at a freezing temperature.

When the plates are made, and properly set and exposed for one month to indurate, frost and wet have no effect on them. The frost test employed was the usual one of a saturated solution of sulphate of soda, and what frost we have had this winter has had no effect on the plates exposed, though it has been sufficiently severe to injure some ordinary concrete exposed under the same conditions.

In the setting of the plates there is an almost imperceptible contraction; but in the finished plates, no contraction or expansion can be detected by ordinary workshop means, with a difference of 70° F. (50°-120°)

Plates, six months old, one inch thick, have been tested by being supported on bearers two feet apart, and loaded by means of weights at the centre till broken. The weights applied varied from 3½ cwt. to 4¼ cwt., the plates being 18 inches broad. The plate that broke at the higher weight was loaded gradually, and when I got to the 4¼ cwt. I had to send for more weights, which took

some two or three minutes; but immediately an extra weight was placed upon the plate it broke in two.

Mr. Darton Hutton, in Vol. LXII. of the *Proceedings* of the Institution of Civil Engineers, describes, in a table, the breaking weights of concrete blocks, treated as beams, but I will only take one of the best results for comparison:—Block No. 10, somewhat honey-combed on the outside, but more solid within, made of one part Portland cement and five parts shingle, and measuring 4 feet long by 12 inches deep by 12 inches broad, supports 3 feet apart, broke with a weight of 9,590 lbs. placed at the centre. Treating it as a beam, and reducing it to the same dimensions as the "paristagan"* plate, the breaking weight of the concrete block becomes 150 lbs., as against 420 lbs. for the "paristagan" plate—the latter being thus nearly three times as strong a beam as that tested in Mr. Hutton's experiments, both test pieces being very nearly the same age.

In joining the "paristagan" plates to make a close joint, I at first tried butting them, but I found that Portland cement did not make a satisfactory joint, even when well rubbed in, as the trowelling only makes the joint black and unsightly. The cement did not harden properly, and this is another case of the want of water at the proper time. Oil putty and stucco were no better, so I checked the plates as in Fig. 1, Plate I., and I found that the joints could be made so fine and sharp that a little boiled oil or paint put on with a brush makes the joint perfectly tight.

The junction of the plates, where they are used for roofing, is checked as in Fig. 2, Plate I., where *a* is a narrow strip of wire netting or gauze, and the nail or bolt goes through the wire and between the plates, and grips the latter to the couples or purlins. The space *b* was filled up and keyed to the wire gauze with cement well worked in with a trowel, but, by and by, I gave up cement in favour of mastic made up with boiled oil and litharge.

The simplest framework of iron that can be made of a house is to form the skeleton or frame of H iron or double-grooved section of iron, and to have the cement concrete plates slid or slipped into the grooves, as in Fig. 3, where *a* and *b* are the plates, and *c* the H iron. The simple frame is tied into a wall-plate at the bottom, and the H iron bent into the form of the slope of the roof, is tied and bolted to a simple ridge-piece at the top. This is the form most suitable for plates that are to be sent abroad for use in sheds

* "Paristagan," meaning "to cover the walls of a house."

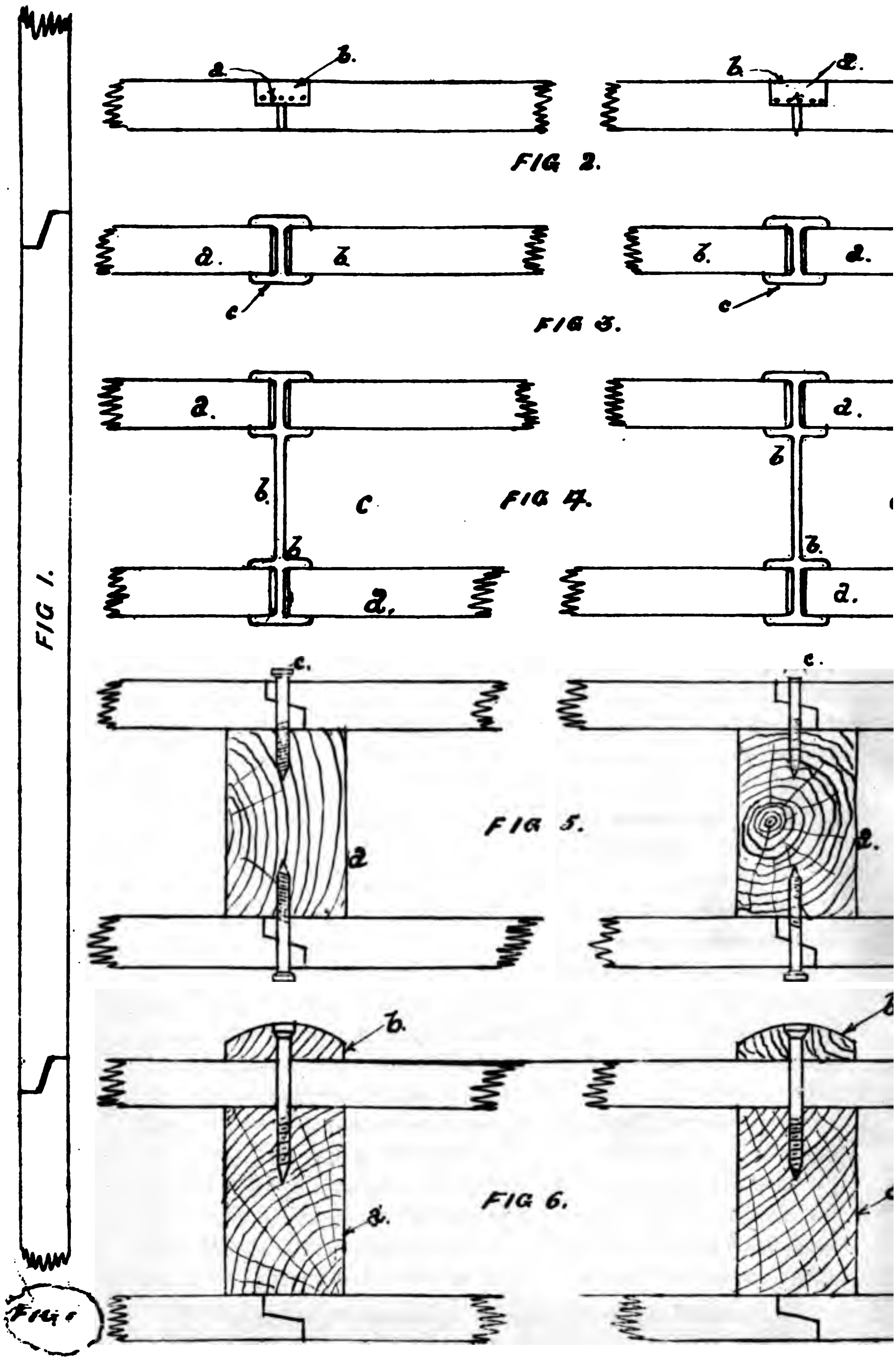
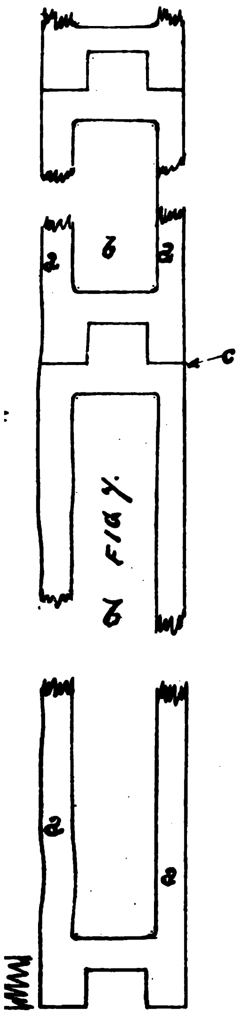


FIG 1.
FIG 2.
FIG 3.
FIG 4.
FIG 5.
FIG 6.
a.
b.
c.



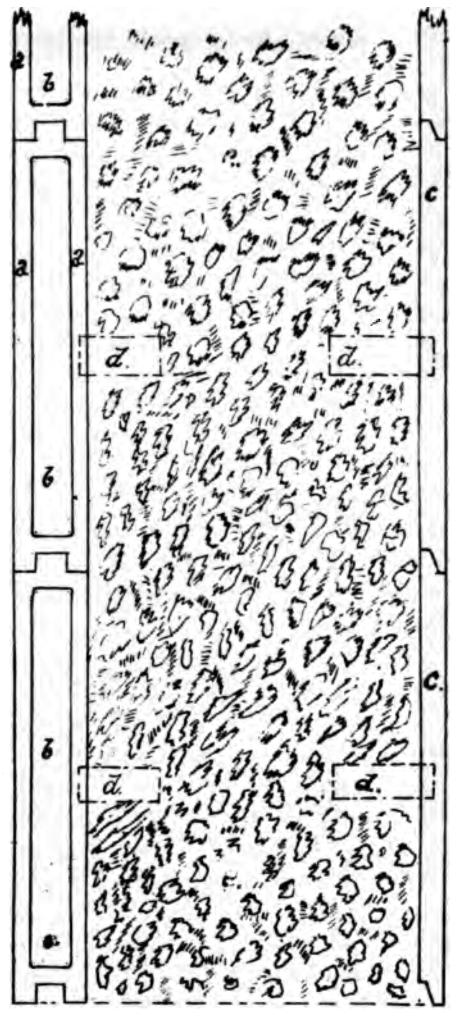


FIG 9.

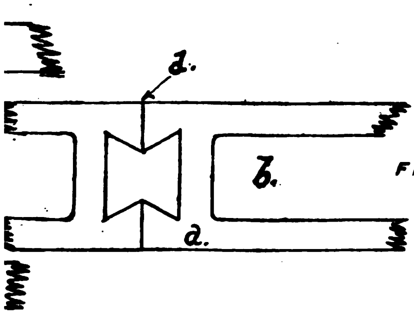
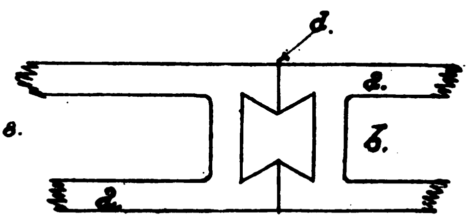


FIG 8.



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and outhouses, soldiers' huts in camp, or erections which require to be vermin proof, or for very thin partitions.

The frame can also be made of a double-grooved section of iron, with a distance-piece between the bars, so as to form a double wall of plates, with an air space between, as in Fig. 4, where *a a* are the plates slid into the grooves in the iron frame, *b*, and *c* is the air space between, to act as a non-conductor of heat.

For the iron beam, *b b*, in Fig. 4, the framing may be made of wood, as in Fig. 5, where the plates are fastened, by means of brass screws, to the framing, and can be easily taken apart again, allowing the whole to be moved away and re-erected on a new site. Another method is to have wooden straps, *b*, Fig. 6, on the outside, which grip the plates between the straps and the framing, *a*. This arrangement gives the outside the appearance of Swiss or half-timbered work. Structures of this form can also be taken down, carried away, and re-erected.

Another form of plate is made hollow, like a box, and the inside is filled up with sawdust, coke breeze, or other similar substance, which acts as a non-conductor of heat, and as a deafener. Plates of this kind are moulded, and the edges turned up round the plate, and the hollow thus formed is nearly filled up to the top with the non-conducting material, and then covered over with concrete or stucco. Plates of this kind are about three inches thick, and are checked into each other in the horizontal joint. The vertical joints are held together by means of a dovetailed feather. In Figs. 7 and 8, *a a*, are shown the walls of these hollow plates, *b* being the non-conducting material, *c* (in Fig. 7) the checked horizontal joint, and *d* (in Fig. 8) is the dovetailed feather in the vertical joint. It is thus seen that the plates are tied together, making, as it were, the plates of each course into one strip, and increasing the strength without using wood standards for partitions at all.

The joints of the plates just described are more for buildings of a movable or semi-permanent nature, and are all of the hollow-wall type, in which the whole strength of the building depends on the strength of the framing. But walls can be made to take up the same strains, as in an ordinary building, by clamping or holding temporarily thin plates, broken-bonded, to give the appearance of ashlar stone work. These can be used for the outside, and hollow plates, as in Figs. 7 and 8, for the inside, the space between the plates being filled up with broken stone or concrete—the strength of

the wall depending in this case upon the thickness of the material between the plates. Fig. 9, Plate I., shows a section of such a compound wall, where *c c* represent the thin outside plate jointed as the others; *a* and *b*, the inside hollow, non-conducting plates; and *e*, the rubble or concrete filling; and *d*, small permanent clips or holdfasts, moulded in the plates, and bent out when the plates are hard.

A small experimental building, which the members are invited to inspect at any time, was erected at 34 Bath Lane, Glasgow, at the end of August. Fig. 10, Plate II., shows the construction of the wood framing, which is covered outside and inside, along with the roof, with thin cement concrete plates. Fig. 11, Plate II., shows the outside of the building. This structure has been exposed to all sorts of weather,—heat, rain, and frost,—which have had no effect upon it up to this date, 13th December, 1893.

In the following table is given a record of the temperatures outside and inside the building, the heat being got from a small oil stove.

What is claimed for this system of building construction, called "Paristagan," meaning "to cover the walls of a house," is—

(1) That a cheap building is obtained, having the appearance of ashlar stone work, which can be made permanent or movable;

(2) That it is durable and unaffected by the weather;

(3) That it is damp-proof;

(4) That the products of combustion and respiration do not and cannot condense upon the inside walls;

(5) That it is easily disinfected;

(6) That it is warm in winter and cool in summer; and

(7) That, although the framing is made of wood, the building is practically fire-proof, as nowhere are the timbers exposed; while the chimney is made of fire-clay rings, and the space between them and the plates is filled in with concrete.

I also show upon the table a "paristagan" plate, with a very finely polished surface as a finish, which is to be tested with steam, and afterwards with blood and the germs of various bacilli, so as to learn if it is absolutely proof against disease contagion, and is a fit material for the walls of a bacteriological laboratory. Till the tests are completed, I am debarred from describing the finishing material used for the surface, but I am in hopes that the plate will stand all the tests that are to be applied.

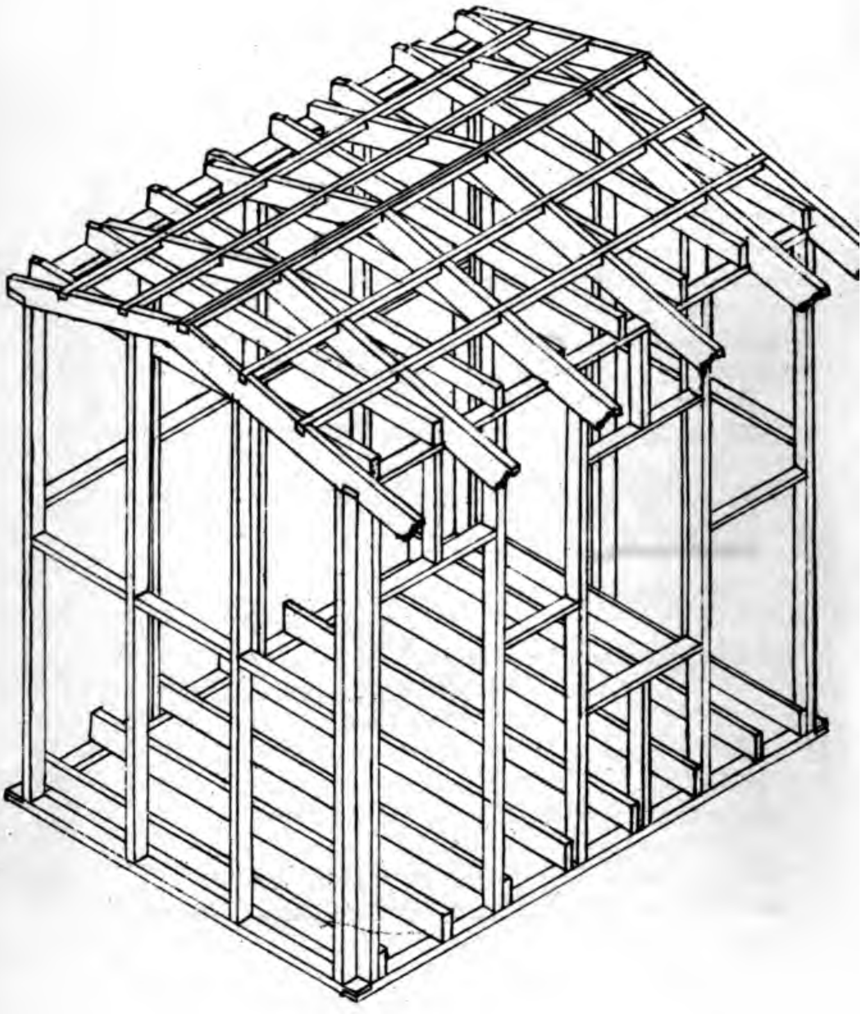

FIG. 10.

APER.

FIG. II.

TEMPERATURE OF BUILDING.

DATE. December, 1893.	INSIDE. A.M. 10	INSIDE. P.M. 4.30	OUTSIDE. A.M. 10	OUTSIDE. P.M. 4.30	DIFFERENCES. A.M. 10	DIFFERENCES. P.M. 4.30
Friday, 1st,	—	50°	—	35°	—	15°
Saturday, 2nd,	36°	53°	35°	43°	1°	10°
Monday, 4th,	49°	62°	49°	55°	0°	7°
Tuesday, 5th,	48°	63°	48°	50°	0°	13°
Wednesday, 6th,	52°	69°	50°	52°	2°	17°
Thursday, 7th,	43°	53°	39°	40°	4°	19°
Friday, 8th,	46°	60°	45°	43°	1°	17°
Saturday, 9th,	41°	57°	39°	39°	2°	18°
Monday, 11th,	41°	57°	40°	40°	1°	17°
Tuesday, 12th,	40°	58°	40°	42°	0°	16°
Wednesday, 13th,	40°	57°	37°	40°	3°	17°
Thursday, 14th,	40°	55°	38°	39°	2°	16°
Friday, 15th,	47°	63°	46°	51°	1°	12°
Saturday, 16th,	53°	62°	53°	53°	0°	9°
Monday, 18th,	48°	60°	46°	43°	2°	17°
Tuesday, 19th,	43°	58°	43°	46°	0°	12°
Wednesday, 20th,	43°	60°	43°	41°	0°	19°
Thursday, 21st,	40°	57°	38°	41°	2°	16°
Friday, 22nd,	50°	59°	48°	44°	2°	15°
Saturday, 23rd,	43°	59°	43°	45°	0°	14°
Mean,	44·37°	58·9°	43·15°	44·1°	1·21°	14·85°
	51·63°		43·62°		8·03°	

VII.—*Above the Snow-line in Scotland.* By Gilbert Thomson, M.A., C.E.

[Read before the Society, 10th January, 1894.]

(Plates III., IV., V., VI.)

It may, on the face of it, seem absurd to speak of the snow-line in Scotland, because, as is well known, we have not in Scotland any hill high enough to give such a line, either in its scientific or its usual popular sense. Lofty though our hills may be in comparison with those of the sister countries, and rugged and grand though many of them are, they have not the dignity of perpetual snow, and their glaciers are only memories of a long-past epoch. So far as a popular notion of snow-line may be said to exist, it would probably be defined as the line above which the snow is perpetual; while the scientific definition given by Tyndall is the line where the quantity of snow which falls is exactly equal to the quantity annually melted. Neither of these conditions can be fulfilled in Scotland, and what I have referred to as the snow-line must be considered as having a temporary, and not a permanent, character. The meaning is perfectly distinct to those who are in the habit of visiting our Scottish hills in winter, and it may be considered practically as the line bounding, at any particular time, the continuous snow. In summer and autumn this line has vanished, for though snow patches may be found all the year round in the sheltered corries of our higher hills, this is not a continuous sheet. In winter, again, the lowlands as well as the highlands are snow-clad, and all of us, willingly or unwillingly, find ourselves above the snow-line. But while at the extremes of the seasons the whole country is alike in being clear or covered, there is a considerable part of the year when the hill-tops are in the icy grip of winter, although spring, or even early summer, is softening the valleys below.

The observation has often been made before now that it is soft and cultivated beauty which attracts the mind in its earlier stages of development; that old writers, for example, in speaking of the

beauties of nature have in their mind nature as modified by art; and that the appreciation of wild grandeur is of comparatively recent date—seeming, in fact, as if the growing artificiality of our ordinary environment were gradually leading us to a higher and higher regard for what is absolutely unartificial. The love of the mountains illustrates this admirably. A century or two ago the mountains were regarded as blots and excrescences which scarcely anybody thought of visiting except under compulsion, and that not only on account of the marauders who might inhabit them, but from the repelling influence of the hills themselves.* To climb to the top of any hill was looked on as a most serious undertaking. In 1726, for example, Daniel Defoe made an ascent of the Cheviots, and wrote an account of the expedition in language which would almost be strong enough for the Matterhorn.† Since then mountaineering has become a pursuit to which many give their attention in summer and in good weather, to the extent that one meets few people who have not ascended one or two of our hills, and that most people have either had the experience of enjoying a magnificent panoramic view, or the disappointment of finding that the mist has reached the top of the hill before them. But while the summer appearance of our Highland hills as seen from the valleys is familiar to everyone, and as seen from their tops is, let us hope, familiar to most, their winter appearance, even as seen from the valleys, is not well known, while the number of those who are familiar with the hill-tops in winter, although rapidly growing, is still very small. I may venture to hope, therefore, that a short description of such scenery, aided by the photographs which, by the kindness of various friends, I am enabled to show, may not be altogether unappreciated by an audience interested in geographical matters.

Alpine climbing, although long scouted as a criminally reckless amusement, has now a well-recognised place, and of those who explore our Scottish mountains in winter, the great majority are either enthusiastic Alpine climbers anxious to keep up their practice, or others who have no such experience, but are led ("misled," some will say) by those who have. I have to confess with regret that I am in the latter category, and that any comparisons of Scottish with Alpine scenery are not at first hand. It may be well to confess also that scientific exploration is not so

* *Scottish Mountaineering Club Journal*, Vol. I., p. 7.

† *Ibid.*, Vol. III., p. 32.

much the inducement as the love of exercise, adventure, and scenery; but, on the other hand, it is impossible to come into close contact with nature without picking up much that is certainly interesting, and possibly something that may be of value. Our experiences, imparted to those able to utilise them, may help to piece up some scientific structure.

It is somewhat difficult to realise the extent to which the country is snow-covered during the spring months. The actual area is really considerable. The snow, which even in summer falls in occasional showers, begins to lie towards the end of the year, and by the new year the hills usually have a considerable coating, although of no great thickness. The great accumulation of snow takes place in the spring, and the end of March shows usually a much heavier coat than the end of December. The quantity, of course, varies enormously in different years. The last two winters, for example, have been comparatively snowless, and at least the earlier part of this winter was the same. Last March (1893) the amount of snow was very small, the snow-line being probably well above 3,000 feet, while in 1889, about the same time of the year, everything above about 1,500 feet in the Central Highlands was white. On New-Year's Day, 1891, the upper part of Ben Voirlich was heavily coated with snow, and immense masses of fog crystals were formed round every point of support, while on the first day of 1894 we sat and lunched comfortably on the bare stones on the sunny side of the cairn. Such extreme differences as this, however, disappear as the winter advances, for in March all the higher tops have a continuous covering, the lower limit of which is very variable. As regards depth of snow, we have records for a series of years from the Ben Nevis Observatory, and from these it appears that, on an average of the last ten years, the deepest snow each year has been about the middle of April. The greatest recorded depth was on April 3rd, 1885, but on 8th May, 1884, the depth was practically the same, being an inch or two short of 12 feet. The smallest maximum was in 1889, when the depth never reached 5 feet, the greatest depth, 57 inches, occurring on April 24th. With regard to other mountain tops, the information available is necessarily of a much more general character, as the task of digging through the snow covering is a task beyond the power, or, at least, beyond the inclination, of an ordinary party of climbers.

More information can be got, however, as to the nature of this covering, which varies from the lightest powder to what is little removed from ice. In the former, a man will sink to the waist whether he goes in head first or feet first (I have tried both ways); while on the latter, the vigorous use of an ice axe may be necessary to make any impression. The newly-fallen snow is soft and often powdery, but its character soon changes under the alternate influence of sun and frost. The result is crusted snow, the thickness and hardness of the crust depending on the extent to which this action has taken place, the surface often being not quite strong enough to sustain the pressure of a foot, while on the north or north-east faces of the hill vast sheets of snow have been transformed into what, from a climber's point of view, is practically ice. Actual ice is largely produced by the complete melting and subsequent freezing of the snow, while rocks are frequently in the condition known as "glazed."

It is not uncommon to find the snow composed of more than one distinct layer. Where a fresh snowfall occurs after the earlier snow has become consolidated, a coating of a few inches in thickness may be formed, and as the adhesion between the two may be very trifling, a slope of this description is rather treacherous. This is well recognised as an Alpine danger, and in Scotland also the upper crust has been known to slip away under the feet of the climbers.

The most striking of the snow effects, however, are those due to wind. We are familiar enough by actual experience with the drifting of snow; we see how it is swept off the exposed parts of the land and deposited wherever there is a sheltered part, such as between hedges or in a railway cutting, and we know (by newspaper reports, at all events) how rapidly these snow wreaths accumulate, and the stoppage of traffic which they occasion. But the biggest Lowland snow drifts are tame compared with what takes place on the hills. If snow is caught by the wind before it has got fairly set, it is whirled clean off the exposed parts, and at a distance the ridges, as seen from a sheltered position, present the appearance of being crested with smoke. To an observer on the ridge the temperature absolutely forbids that idea. The cloud of snow dashes fiercely against him; if hard and dry, the particles sting like small shot; while, if moist, the windward parts of his clothing and person are heavily coated. The strength of the wind is on some occasions so great that there is nothing for it but to

hold hard in the squalls, and make such progress as is possible in the lulls, progress against the gusts being absolutely out of the question. On a narrow ridge care is needed to prevent one's self being carried over; on a broad place care is no less necessary to steer correctly. The weather is not always, nor indeed often, like this, but a really calm day is the exception, and the effects of the wind are very striking. The corries are filled with snow of unknown depth; rock faces are plastered over; the surface of hard snow is scored by the ice particles driving over it; and the escarpment of the hill, where the summit breaks off in a sharp line of cliff, is fringed with a heavy snow cornice. The snow-filled corries often form convenient lines of ascent, possible only because of the snow. I have seen a party steered through mist chiefly by the wind markings, with only occasional reference to the compass, while the cornices, magnificent as they seem when viewed across a corrie, or from below, become dangerous pitfalls for anyone who approaches carelessly from the upper side. The snow surface is continuous; there is nothing to indicate that the solid rock no longer gives its support; but the edge would most probably break off under the weight of a man, and drop him either over a perpendicular precipice, or on to a steep slope of snow or ice, where his fate would be no less certain. This, again, is a well known Alpine danger, and the fact that our cliffs are measured by hundreds of feet as against the Alpine thousands, would not materially affect the result in the case of a fall. I have seen the snow on the upper part of a cornice scored in such a way that it resembled the weathered edges of stratified rock, the bed of the strata about parallel with the steep slope below, and suggesting that the cornice had been built up of successive layers of snow, with the top planed down by the wind. In the gullies the snow is often marked by the descent of debris from above, and a dirty surface on a snow gully is looked on by a climber either as a warning or a challenge, according to his individual temperament.

One of the most beautiful effects is due to the action of wind, not on snow, but on water vapour. The particles of vapour are driven against some substance at a low temperature, and frozen to it, growing until the object, whatever it may be, is coated with beautiful ice feathers. Not a rock, not a stone, but has this coating of delicate flowering, and, on the other hand, a most remarkable example is given of the effect which apparently trifling causes may produce. The wire fencing by which some of the

higher hills are crossed is always found in a dilapidated state. The wires are twisted and torn, the iron uprights are bent and broken, the heavy stone supports are sometimes uprooted. A storm which could create such havoc by its grip on a wire fence is utterly inconceivable. But these wires become cores for the fog-crystals, and I have seen a fence where each wire was encased in a cylinder of ice, something like a foot in diameter. The weight of such a mass seemed sufficient to account for the destruction, to say nothing of the grip thereby afforded to the wind.

One or two other points with regard to the snow may be briefly mentioned. The colouring at dawn or sunset of the snowy summits is exquisite. The rich red glow of the hills touched by the sun, contrasted by the dead coldness of the shaded parts, and with the darkness of the valleys below, gives an impression which to experience is to remember. Another colour effect, on a small scale, is equally remarkable. In certain conditions of the snow the mark made by the foot sinking deep, or by the point of the axe, appears to be filled, as it were, with a delicate blue vapour, in somewhat startling contrast with the white surface around.

The means of access and the methods of locomotion should perhaps be referred to. There are both natural and artificial difficulties to be overcome in reaching many of our hill-tops—the most formidable of the latter, at certain seasons, being the not-unnatural objection of sportsmen to see tourists in a deer forest, which their presence will spoil for weeks. In winter the possible increase of natural difficulties is compensated by the disappearance of the artificial. There may be one or two curmudgeons who would try to object, but, practically, to the winter climber the most strictly preserved deer forests are as free as the public highway, and a courteous request for permission to explore usually brings not only the permission sought, but offers of every possible assistance as well. The natural difficulties are also very much exaggerated. The following newspaper paragraph, which appeared within the last week, and is given *verbatim*, is as good an illustration as any:—"Mountaineering in Winter.—The fate of Professor Marshall, who was killed while ascending the Scaw Fell; that of Dr. Kohn, who lost his life on Mount Gross Glockner; and that of the nine gentlemen who made up their minds to greet the New Year from the summit of the Guifetti peak, nearly 12,000 feet high, demonstrate the folly of mountaineering in winter. Alpine climbing, always more or

less dangerous even in the favourable summer months, is downright madness in the season of snow and cold." The writer of that paragraph showed an acquaintance with his subject only rivalled by that of the gentleman who some time ago wrote to the *Herald* with the luminous suggestion that, with a view to increase the brilliancy of incandescent lamps, the vacuum should be replaced by oxygen.

Climbing in winter, with proper precautions, is not a whit more dangerous than in summer, so far, at least, as Scotland is concerned. Accidents happen much more frequently to those who are doing an easy thing carelessly than a difficult thing with deliberation. No one is entitled to pose as an authority on climbing unless he has had experience in the high Alps, and I have not had that experience. But it needs no skill to see that, though climbing in winter is totally different from climbing in summer, the difference is not greater than that between walking up Ben Lomond and climbing, say, any of the Coolins, both in summer. If climbing, as distinguished from walking up a hill, is justifiable at all, winter climbing is equally so. But it is Alpine work, and must be treated accordingly. The object usually is, not to get to a hill-top by the easiest route, but to select that route which will give most interesting exercise. Rain, snow, wind, or mist, is not usually in Scotland considered a sufficient reason for giving up an expedition, and, therefore, suitable provision, compasses, and the like, must be made against losing the way.

The usual Alpine equipment of rope and axe must be taken if anything serious is to be done, and a party not so provided will, in most cases, either have to give up something they would like to do, or to run an unjustifiable risk. One of the most dangerous-looking performances is probably cutting steps up a steep snow slope, with, perhaps, a precipice below. But a properly equipped party, going to work systematically, runs no risk. The individuals composing it are roped together; and if it is a really serious place, only one man moves at a time, the others being "anchored"—that is to say, the axe shafts are buried in the snow, and the rope is caught round them. The extent of the risk is an unpleasant slide, and an unpleasant jerk. A slope of snow, which from above looks almost vertical, is not specially difficult to ascend. The angle in imagination is always greater than in reality, and not much reliance is to be put on a report that a party ascended a slope *estimated* at so many degrees. It resembles the fish that the

"ABOVE THE SNOW-LINE IN SCOTLAND."

Fig. 1.

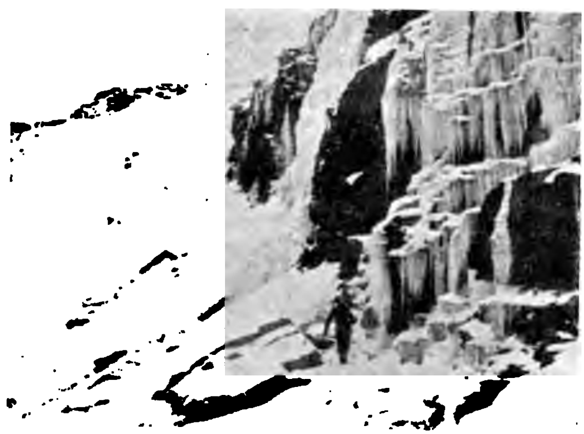

Fig. 2.

Fig. 3.

angler nearly caught. The steepest continued slope I have measured was 50°, but I should certainly have guessed it 10° more.*

The temperature is frequently low, but the cold is not so excessive as one might imagine. Until the last frost, the Ben Nevis Observatory had never recorded a reading of zero, the lowest record being 2·7. On Saturday last a reading of zero was recorded. But, apart from extremes, the hill-top temperatures are much below those of the valleys. On New Year's day this year, mild though it was in Glasgow, the thermometer, about two o'clock in the afternoon, registered on the top of Stuc-a-chroin (just over 3,000 feet high) 26° in the sun, and 15° in the shade.

The Scottish Mountaineering Club has set itself to collect information of every description with regard to the mountains, and among other means of attaining this object has gradually acquired a large collection of photographs taken among the mountains, chiefly by its own members. Besides paper prints, it possesses a large number of lantern slides, and by a selection from these some idea may be given of the winter appearance of our mountains. The colour and the storm effects are unfortunately beyond their power, and no conception of the grandeur of mountain scenery, as seen in snatches through breaks in the storm, can be conveyed to any one who has not experienced it. Many of the striking appearances however can be shown. Of the photographs shown, about eighty in number, the following have been reproduced:—Plate III., Fig. 1, shows the north face of Ben Cruachan, with a roped party traversing what was practically a slope of ice. This photograph was taken on March 27th, 1892. Fig. 2 is a winter scene on Ben Douran, just north of Tyndrum, the immense icicles with which the rock is festooned giving a vivid idea of the intensity of the winter. This view was taken on 18th April, 1892. Fig. 3, taken three days earlier, shows the steep face of Stob Ghabhar, a few miles further north, the narrow white gully in the upper part being the route traversed with considerable difficulty by a climbing party. These three views are from photographs by Mr. Willian Douglas. The two on Plate IV. are from photographs taken in April, 1890, by Mr. J. Craig Annan. Fig. 1 is a view of a rock on Stobinian (just north of Balquhidder), which illustrates well the frost feathering which is so beautiful a feature in our mountain scenery; and Fig. 2 is taken from the

* 59° was measured in Scotland in March, 1894.

top of Ben More, looking south. The Ben More cairn is in the foreground, while the peak of Stobinian, and the lower peak of Stob Coire an Lochain, appear in the distance. Plate V. consists of Ben Nevis photographs (23rd March, 1893), selected not to show any view of the hill, but to illustrate the snow effects. The "cornicing," in particular, is well seen. These photographs were taken in March, 1893, by Mr. John Rennie. Plate VI., Figs. 1 and 2, are from the Teallach, a very striking mountain in the west of Ross-shire, overlooking Dundonnell. It is one of the least known of the Scottish mountains, and was visited at Easter of last year by a party of the Scottish Mountaineering Club, for the purpose both of climbing and exploring. In the *Club Journal* for January, 1894, is published the most accurate map and only full description of the district. The flat beds of sandstone, with their seams picked out with white, give an appearance of giant masonry. Fig. 1 shows Sgurr Fiona, one of the numerous peaks of the ridge, taken from another part of the ridge; while Fig. 2 is a "tooth," as seen close at hand. These photographs were taken on 31st March, 1893. Fig. 3 is a summer photograph, showing a mist effect on Sgurr Alasdair, the highest of the Skye hills. The name Alasdair (Alexander) is from the late Sheriff Alexander Nicolson, who at the time of his death was a Vice-President of the Scottish Mountaineering Club, and who was one of the most enthusiastic of the older generation of mountaineers. These three photographs are also the work of Mr. Douglas.

There is no doubt that winter climbing in Scotland is rapidly growing in popularity, and I believe that to be in every respect an advantage. Apart from the individual benefit and enjoyment, there is ample scope for observation which will be of scientific value as well as of general interest. But it may be well to point out that care is needed in the undertaking. The advance of Alpine climbing in public favour was marked by many fatalities caused by the want of the most elementary precautions. A similar cause might easily produce a similar result here. The man of deficient stamina, the man who turns giddy on looking from a height, and the man who suffers readily from exposure, are all out of place. So is the man who, however well qualified physically, has not had the necessary experience, unless he is in company with, and thoroughly obedient to, those who have. Then, again, there are men to whom everything becomes a danger, who in whatever they undertake will take chances, or "trust to Providence,"

"ABOVE THE SNOW-LINE IN SCOTLAND."

Fig. 1.

Fig. 2.

Fig. 3.

From Photographs by Mr. John Rennie

"ABOVE THE SNOW-LINE IN SCOTLAND."

Fig. 1.

Fig. 2.

Fig. 3.

From Photographs by Mr. William Dougl

without using the means which Providence puts into their hands. When these men take to climbing, as some of them doubtless will, we may look for accidents. More than that, accidents are *possible* to the most experienced and careful party. Circumstances may occur which no skill or forethought could provide against, but these will be few compared with the risks incurred in many pursuits which are not classed as dangerous. As against that possibility there is to be put the hope that results of value may be derived, and the certainty that the exercise tends to develop faculties which in our artificial life are apt to be neglected, and to enrich the mind by the contemplation of some of the fairest and some of the grandest works of nature.

VIII.—*Some Notes on the Place-Names and Dialect of Shetland.* By DAVID ROSS, M.A., B.Sc., LL.D. *(A Communication from the Philological Section.)*

[Read before the Society, 24th January, 1894.]

(PLATE VII.—MAP OF BRESSAY AND NOSS.)

AMID the great variety of languages spoken from the Ganges to the Atlantic, modern philology detects much that is common to all. We observe how in historic times languages have gradually become modified; we collect and classify the facts, and from them we infer the laws according to which the changes are effected. By a farther application of these same laws, we are able, roughly, to trace each language back beyond the historic period to a time when the differences between the various tongues were merely dialectic.

Early literatures are, therefore, of the highest value in this investigation, for they enable us to confirm or to correct the conclusions arrived at by the laws of philology. For this purpose no literatures have proved so useful as two—geographically so far removed as to be the extremes of the series,—the Sanskrit and the Icelandic. With the latter only we have here and now to do. Its philological value arises from the fact that it represents one of the oldest forms of the Gothic element in our language, cut off from the allied forms at a very early period in the process of differentiation, and very soon becoming fixed by the rise of a unique and vigorous literature, preserved with the greatest care to the present time. If Spenser could look for authority to Chaucer—"Well of English undefiled"—we can, in the texts of the Scalds and Saga-men, go farther back, and draw directly from one of the purest and most copious springs of that celebrated fountain.

Towards the close of the ninth century, Harald Harfagar (Fairhair) made himself sole ruler of Norway, with the firm resolve of welding into a homogeneous whole the petty clans whose feuds and quarrels had filled the land with blood and slaughter. His relentless energy soon accomplished his purpose. The milder tribes submitted, but the bolder spirits sought to

maintain their independence in exile—in the Orkney and Shetland Islands, in the Hebrides, and in Ireland, whence they made plundering descents upon the coast of their mother country, Norway, now hostile to them. But Harald was not to be trifled with. He followed the exiles to their new homes, crushed their power in the islands, and forced many of them to seek refuge in the far-off and almost unknown Iceland. The first settlers arrived in that country of frost and fire about A.D. 874, and other exiles followed from time to time, all animated by a hatred of the new order of things in Norway, but all cherishing an intense love for the old country, its religion and mythology, its legendary lore, and the heroic tales of its fells and fiords. These formed topics for the poems of the Scalds, which were committed to memory, and recited in the great Skali (or halls) at the winter feasts, and which became exceedingly popular, and laid the foundation of a noble literature. Then came the Saga-men, who, working upon the materials thus provided, produced those wonderful prose epics, the Sagas, a form of literature peculiar to Iceland, and its greatest glory. By Ari, the learned, and by Snorri Sturlason, men whose work would have made them famous in the literature of any country, these Sagas were carefully edited and committed to writing so early that they had suffered little change from their original form. Thus about forty Sagas have come down to us, some of great length, and have proved of the highest value in interpreting words and names in our language, of whose origin we should otherwise have been left in ignorance or in doubt.

This I shall attempt to illustrate by a series of place-names in the Shetland Islands, which were under the sway of the Scandinavians until 1468, when they were handed over to the Scottish king, James III., as a pledge for a portion of the dowry of the Danish princess whom he married. Since that period the isles have been attached to Scotland, the Norse language has ceased to be spoken, and every year the dialect is being more and more assimilated to that of the adjoining mainland. Place-names in a settled district have a permanence not equalled by any other class of words. Even when the area has been overrun by conquerors using a totally distinct language, the original names, under various disguises, can easily be recognised by the philologist. Thus, in the Western Isles, where Gaelic was the only language spoken for the last five centuries, Captain

"ABOVE THE SNOW-LINE IN SCOTLAND."

Fig. 2.

Fig. 1.

From Photographs by Mr. J. CRAIG ANNAN.

angler nearly caught. The steepest continued slope I have measured was 50°, but I should certainly have guessed it 10° more.*

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The Scottish Mountaineering Club has set itself to collect information of every description with regard to the mountains, and among other means of attaining this object has gradually acquired a large collection of photographs taken among the mountains, chiefly by its own members. Besides paper prints, it possesses a large number of lantern slides, and by a selection from these some idea may be given of the winter appearance of our mountains. The colour and the storm effects are unfortunately beyond their power, and no conception of the grandeur of mountain scenery, as seen in snatches through breaks in the storm, can be conveyed to any one who has not experienced it. Many of the striking appearances however can be shown. Of the photographs shown, about eighty in number, the following have been reproduced:—Plate III., Fig. 1, shows the north face of Ben Cruachan, with a roped party traversing what was practically a slope of ice. This photograph was taken on March 27th, 1892. Fig. 2 is a winter scene on Ben Douran, just north of Tyndrum, the immense icicles with which the rock is festooned giving a vivid idea of the intensity of the winter. This view was taken on 18th April, 1892. Fig. 3, taken three days earlier, shows the steep face of Stob Ghabhar, a few miles further north, the narrow white gully in the upper part being the route traversed with considerable difficulty by a climbing party. These three views are from photographs by Mr. Willian Douglas. The two on Plate IV. are from photographs taken in April, 1890, by Mr. J. Craig Annan. Fig. 1 is a view of a rock on Stobinian (just north of Balquhidder), which illustrates well the frost feathering which is so beautiful a feature in our mountain scenery; and Fig. 2 is taken from the

* 59° was measured in Scotland in March, 1894.

top of Ben More, looking south. The Ben More cairn is in the foreground, while the peak of Stobinian, and the lower peak of Stob Coire an Lochain, appear in the distance. Plate V. consists of Ben Nevis photographs (23rd March, 1893), selected not to show any view of the hill, but to illustrate the snow effects. The "cornicing," in particular, is well seen. These photographs were taken in March, 1893, by Mr. John Rennie. Plate VI., Figs. 1 and 2, are from the Teallach, a very striking mountain in the west of Ross-shire, overlooking Dundonnell. It is one of the least known of the Scottish mountains, and was visited at Easter of last year by a party of the Scottish Mountaineering Club, for the purpose both of climbing and exploring. In the *Club Journal* for January, 1894, is published the most accurate map and only full description of the district. The flat beds of sandstone, with their seams picked out with white, give an appearance of giant masonry. Fig. 1 shows Sgurr Fiona, one of the numerous peaks of the ridge, taken from another part of the ridge; while Fig. 2 is a "tooth," as seen close at hand. These photographs were taken on 31st March, 1893. Fig. 3 is a summer photograph, showing a mist effect on Sgurr Alasdair, the highest of the Skye hills. The name Alasdair (Alexander) is from the late Sheriff Alexander Nicolson, who at the time of his death was a Vice-President of the Scottish Mountaineering Club, and who was one of the most enthusiastic of the older generation of mountaineers. These three photographs are also the work of Mr. Douglas.

There is no doubt that winter climbing in Scotland is rapidly growing in popularity, and I believe that to be in every respect an advantage. Apart from the individual benefit and enjoyment, there is ample scope for observation which will be of scientific value as well as of general interest. But it may be well to point out that care is needed in the undertaking. The advance of Alpine climbing in public favour was marked by many fatalities caused by the want of the most elementary precautions. A similar cause might easily produce a similar result here. The man of deficient stamina, the man who turns giddy on looking from a height, and the man who suffers readily from exposure, are all out of place. So is the man who, however well qualified physically, has not had the necessary experience, unless he is in company with, and thoroughly obedient to, those who have. Then, again, there are men to whom everything becomes a danger, who in whatever they undertake will take chances, or "trust to Providence,"

"ABOVE THE SNOW-LINE IN SCOTLAND."

Fig. 1.

Fig. 2.

Fig. 3.

From Photographs by Mr. John Renn

"ABOVE THE SNOW-LINE IN SCOTLAND."

Fig. 1.

Fig. 2.

Fig. 3.

From Photographs by Mr. WILLIAM DOUGL

without using the means which Providence puts into their hands. When these men take to climbing, as some of them doubtless will, we may look for accidents. More than that, accidents are *possible* to the most experienced and careful party. Circumstances may occur which no skill or forethought could provide against, but these will be few compared with the risks incurred in many pursuits which are not classed as dangerous. As against that possibility there is to be put the hope that results of value may be derived, and the certainty that the exercise tends to develop faculties which in our artificial life are apt to be neglected, and to enrich the mind by the contemplation of some of the fairest and some of the grandest works of nature.

VIII.—*Some Notes on the Place-Names and Dialect of Shetland.* By DAVID ROSS, M.A., B.Sc., LL.D. *(A Communication from the Philological Section.)*

[Read before the Society, 24th January, 1894.]

(PLATE VII.—MAP OF BRESSAY AND NOSS.)

AMID the great variety of languages spoken from the Ganges to the Atlantic, modern philology detects much that is common to all. We observe how in historic times languages have gradually become modified; we collect and classify the facts, and from them we infer the laws according to which the changes are effected. By a farther application of these same laws, we are able, roughly, to trace each language back beyond the historic period to a time when the differences between the various tongues were merely dialectic.

Early literatures are, therefore, of the highest value in this investigation, for they enable us to confirm or to correct the conclusions arrived at by the laws of philology. For this purpose no literatures have proved so useful as two—geographically so far removed as to be the extremes of the series,—the Sanskrit and the Icelandic. With the latter only we have here and now to do. Its philological value arises from the fact that it represents one of the oldest forms of the Gothic element in our language, cut off from the allied forms at a very early period in the process of differentiation, and very soon becoming fixed by the rise of a unique and vigorous literature, preserved with the greatest care to the present time. If Spenser could look for authority to Chaucer—"Well of English undefiled"—we can, in the texts of the Scalds and Saga-men, go farther back, and draw directly from one of the purest and most copious springs of that celebrated fountain.

Towards the close of the ninth century, Harald Harfagar (Fairhair) made himself sole ruler of Norway, with the firm resolve of welding into a homogeneous whole the petty clans whose feuds and quarrels had filled the land with blood and slaughter. His relentless energy soon accomplished his purpose. The milder tribes submitted, but the bolder spirits sought to

maintain their independence in exile—in the Orkney and Shetland Islands, in the Hebrides, and in Ireland, whence they made plundering descents upon the coast of their mother country, Norway, now hostile to them. But Harald was not to be trifled with. He followed the exiles to their new homes, crushed their power in the islands, and forced many of them to seek refuge in the far-off and almost unknown Iceland. The first settlers arrived in that country of frost and fire about A.D. 874, and other exiles followed from time to time, all animated by a hatred of the new order of things in Norway, but all cherishing an intense love for the old country, its religion and mythology, its legendary lore, and the heroic tales of its fells and fiords. These formed topics for the poems of the Scalds, which were committed to memory, and recited in the great Skali (or halls) at the winter feasts, and which became exceedingly popular, and laid the foundation of a noble literature. Then came the Saga-men, who, working upon the materials thus provided, produced those wonderful prose epics, the Sagas, a form of literature peculiar to Iceland, and its greatest glory. By Ari, the learned, and by Snorri Sturlason, men whose work would have made them famous in the literature of any country, these Sagas were carefully edited and committed to writing so early that they had suffered little change from their original form. Thus about forty Sagas have come down to us, some of great length, and have proved of the highest value in interpreting words and names in our language, of whose origin we should otherwise have been left in ignorance or in doubt.

This I shall attempt to illustrate by a series of place-names in the Shetland Islands, which were under the sway of the Scandinavians until 1468, when they were handed over to the Scottish king, James III., as a pledge for a portion of the dowry of the Danish princess whom he married. Since that period the isles have been attached to Scotland, the Norse language has ceased to be spoken, and every year the dialect is being more and more assimilated to that of the adjoining mainland. Place-names in a settled district have a permanence not equalled by any other class of words. Even when the area has been overrun by conquerors using a totally distinct language, the original names, under various disguises, can easily be recognised by the philologist. Thus, in the Western Isles, where Gaelic was the only language spoken for the last five centuries, Captain

Thomas, on his survey, found that three-fourths of the place-names were easily referred to a Norse or Icelandic origin. In Shetland, as might be expected, the place-names admit of a still more easy reference to that source. Indeed, excluding modern importations (as Belmont, Waterloo, &c.), the only names of a different origin are a few Celtic ones, evidently traceable to missions of the Culdees, who seem to have had a predilection for outposts in lonely isles and remote headlands. Of the Shetlands I have chosen two, Bressay and Noss, which, from their proximity to Lerwick, the chief port, are the best known to visitors. The names in Norse are accurately descriptive, but to the inhabitants of the present day they are in most cases mere place-names, the original meanings of which are as entirely unknown as are the meanings of the Norse names in the Hebrides to the Gaelic-speaking islanders of our own time. With the aid of the accompanying map the characteristic nature of many of the names will be at once recognised.

Isle of Noss.

Hovie; Icelandic, höfdhi; head, promontory.

Noup; Norse, nup; Ic. nupr; top of a mountain; a cliff nearly 600 feet high.

Clitters; rocks lying out from the bottom of a cliff (very descriptive here); Ic. klettr, a flat rock.

Fugla Skerry; bird skerry or isolated rock; Ic. fugl, bird; sker, skerry.

Paplas Goe; Ic. Papar, Culdees; gía, rift, creek.

Mansie Berg; Mansi, diminutive of Magnus, a very common name in Shetland; Ic. berg, rock.

Mels (Mel); Ic. melr, a beach with both sand and stones. Many places have been so called, but the modern name is commonly Mail, and the meaning has been forgotten.

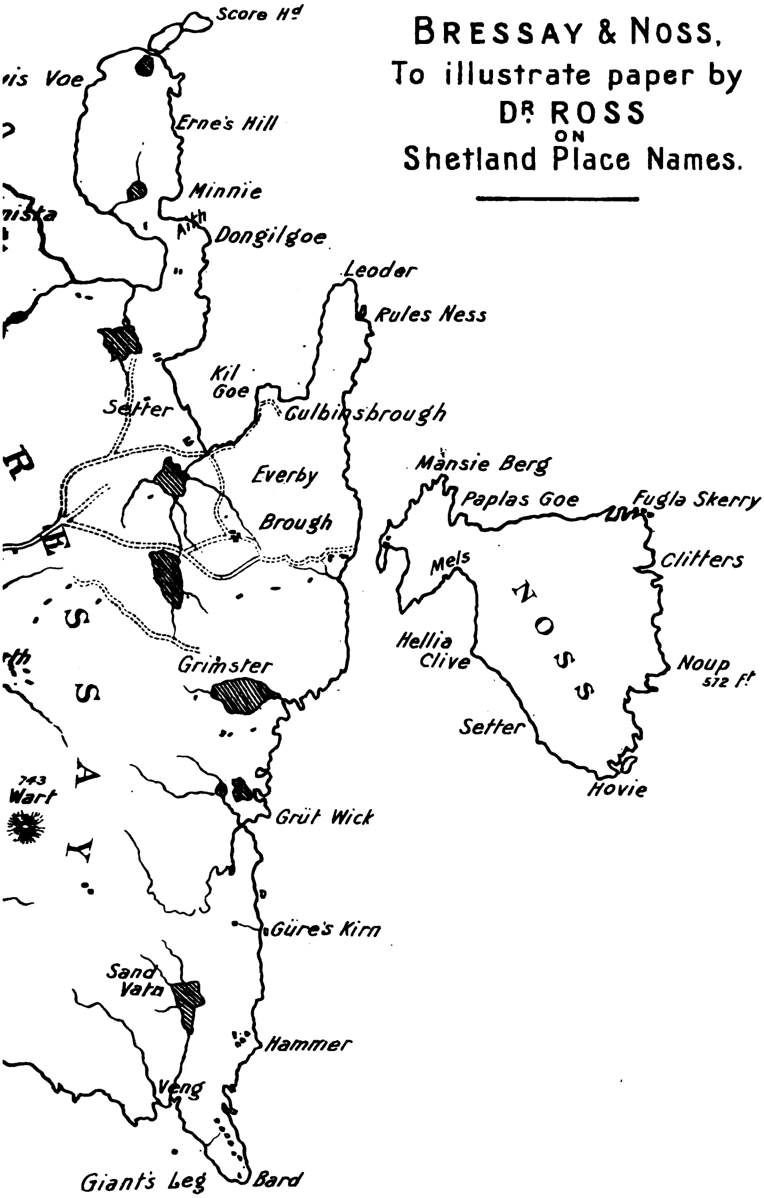
Hellia Clĭve; Norse, hellir, a cave. Helyr is the name usually applied to a long cavern drilled by the sea in a cliff. Clĭve from Ic. Kleif, a cliff. The modern pronunciation is often clùv.

Setter; outlying farm or pasture at a distance from the main or home farm. The word is still used in Norway to denote the summer pasturage on the mountains.


MAINLAND
Grimista
Hogan
BRESSAY
LERWICK
Larness
Twagoes
Knab
SOUND
Hellia
Gulber Wick
The Nizz
Kirkabister
Lighthouse

BRESSAY & NOSS.

To illustrate paper by DR ROSS ON Shetland Place Names.



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Noss; Norse, nes, naze, cape. The island is by far the most conspicuous in Shetland to vessels approaching from the east, owing to the height of the magnificent cliff at the Noup.

Bressay.

Bressay; Bardsey. The ay, ey, a, oe, represent the Norse termination for an island of the second magnitude, as Islay, Jura, Faroe. An island of the first magnitude was called a land, as Iceland, Zealand; and of the third magnitude, a holm, as Doorholm, Geirholm. The southern extremity of Bressay is a rocky headland of the form called a Bardi—that is to say, the top projects beyond the base. Bardi is also a giant; and a rock on this promontory shoots out into the sea, and, forming a fine column, sinks perpendicularly into the water, leaving a passage between it and the bottom of the cliff. This rock is known as the Giant's Leg. Formerly there were two such rocks, when the analogy to a giant's legs must have readily suggested itself. Hence Bressay is the Giant's Isle. Bardsey, an isle off the Welsh coast, shows the name in a form more easily derived from Bardi. The explanation of the name Bressay as the Broad Island cannot well be maintained, either etymologically or descriptively.

Hammer; Norse, a steep place, a hillside with many large rocks exposed thereon. Confer Hammerfast in Norway. Ic. hamarr, a crag.

Güre's Kirn; Ic. gygr, an ogress, a witch. The witch's churn. Here the sea has drilled a *helyr* at the bottom of the cave in the cliff below. The rocks above the inner end of the cave have fallen in, and have left a huge *lacuna* of great width and depth, in form exactly resembling a churn.

Grūt Wick; Ic. grjót vík = rocky bay: the creek is full of huge rocks and boulders. Vík appears as Wick in names in Shetland—Haroldswick, Sandwick, &c.; and in the Hebrides as Uig. The Norse rovers took their name from this word—Vík, a bay; viking, the industry they carried on in the bays, namely, plunder; vikingr, the rovers themselves.

Grimster; Grim's stadr, Grim's station, place, farm, or abode. Stadr often appears as Sta, as in Busta, Ulsta. In the Hebrides it assumes the form Shadder, as Kershadder.

Brough; Ic. borg, fort, castle, hill. A very common name in Shetland, where abound what have been vaguely called Pictish castles.

Everby; Norse, yfir, over, above; and Danish, by, abode. It lies on a height overlooking the place next named.

Culbinsbrough; Kolbein's Borg. The name Kolbein occurs often in the Sagas. The modern name of the hamlet is Cullisbrough. It is of ancient date, and was an ecclesiastical centre from Culdee to Reformation times.

Kil Goe; Kirk Goe, church creek. The creek for landing to visit the church at Culbinsbrough. Celtic, kil, church; Ic. gía, creek.

Rulesness; Norse, rool, a young horse. The ness, or peninsula, where young horses were kept apart from the others. The expression "a pellat rool" means a young horse with his old coat of hair hanging about him in matted locks, but is often used as a term of reproach to a wretchedly clad person. Danish, pialtet, ragged.

Leoder; from old Teutonic root, hlu, to sound, to be noisy. Here the sea entering a *helyr*, or cave, has burst a way to the top of the cliff, whence during storms the water spouts up with great noise.

Dongilgoe; Dun-gall-goe, probably creek of the fort of the foreigners. Celtic, dun, fort, and gall, foreign; with the Ic. gia, creek. Quite near there are the remains of a Pictish brough.

Aith (pronounced *aid*); Old Norse, eid, an isthmus. Very common name in Orkney and Shetland, and always characteristic.

Minnie; Ic. minni, the mouth of a firth.

Erne's Hill; Ic. örn, arn, eagle. Eagles formerly built their nests in the fine cliff on the eastern side of this hill.

Score; Norse, skard, a cut, a mark. Here a headland is separated from the next land by a ravine a few feet widé, but very deep.

Elvis Voe; Ic. álfr, elve, fairy; and vágr, a bay, or rather a long narrow inlet. Vágr has become Voe in most of the modern forms of the name; but it appears as -way in Scalloway (that is, the voe of the skali or booths), and also as -wall in Kirkwall (the church on the inlet or narrow bay).

Gunistae; Gunar's stadr or -sta; Gunar was a common Icelandic name.

Beosetter; Ic. Bú-setter, cattle pasture.

Hōgan (The Hogie); probably from Ic. hoggva, to hew, to cut. Here peats are cut and carried in boats to Aith and elsewhere. Hogalief was a payment for the right of cutting peats.

Sweenie Vatn; Ic. vatn, loch; Sweyn's Loch. The meaning of vatn has been forgotten, so now people speak of Sweenie Vatn Loch, Sand Vatn Loch, as they do on the Clyde of Brodick Bay, although Brodick is Broad Wick—that is, Broad Bay.

Larness; Ic. leir, clay, the clayey ness; very descriptive.

Mail for Mel; see place of same name in Noss.

Nestigarth, for Noustigarth; Ic. naust, a place for pulling a boat up on the land, usually a deep trench to prevent the wind from overturning the boat. Garth, from Ic. garthr, yard, court, garden, field.

Ham; Norse, signifying home. The original or chief settlement in an island or district usually bears this name.

Wart; Ward or Watch Hill, a common name for the highest hill in each island.

Kirkabister; Kirk-bu-stadr, the church beside the cattle steads.

Daal; Ic. dalr, valley; very characteristic here.

Sand Vatn; Sandy Loch.

Veng; probably Ic. vin, a meadow. The pasture is here very rich.

Ord; Vord, beacon hill.

On Mainland (Opposite Bressay).

Grimista; Grim's Stadr. Confer Grimster in Bressay.

Lerwick; leir vik, clay bay. Confer Lerness in Bressay.

Twagoes; the two creeks; twa, gía.

Knab; Knob, nop, nob; very descriptive.

Hellia; Rock cave. Confer Hellia Clive in Noss.

Nizz; Ness.

Gulberwick; Gulbrand's [Guthbrandr] Bay.

The following terms, but slightly altered from the Old Norse, are still in common use as place-names, or are used in forming compound names:—

Air,	eyri, ...	a shingly beach.
Büd,	buth, ...	a booth, a shed.
Cuppa,	kuppo, ...	a high rock or elevation.
-gil,	gil, ...	a ravine.
-fell,	fiall, ...	hill, moorland.
How, Hug,	haugr, ...	commonly a sepulchral mound. a chambered conical tomb.
Hope,	hóp, ...	a bay, harbour. Confer Long Hope, St. Margaret's Hope.
Mool,	muli, ...	a headland, mull.
Pund,	A.S. pyndan, ...	to impound, seize; also, an inclosure.
Sneug,	sneveg, ...	cliff, abrupt hilltop.
Taing,	A.S. tang, ...	a rocky cape running out under water.

Various old terms are still in use, chiefly in connection with the sea and fishing. They exhibit little change from their Norse originals:—

Affrug,	af, rógg, ...	the broken backwater of a retreating wave.
Agg,	Ag, ...	disturbed sea after a gale.
Andoo,	andou, ...	to keep a boat at rest by means of oars.
Flow,	floi = bay, ...	example—Scapa Flow.
Froad,	froda, ...	froth.
Haaf,	haf (sea), ...	the open sea, especially the ling-fishing grounds far from shore.
Mareel,	maurildi, ...	phosphorescence, chiefly at sea.
Meads,	mid, ...	meets, marks on shore to indicate exact positions at sea.
Roust,	röst, ...	a tidal rapid, vortex, whirlpool.
Banks, ...		a line of high rocks on the coast.
Drongs, ...		high rocky islets.
Grimster, ...		a large ebb.
Stack, ...		a towering rock.
Staaf, ...		an upright rock.

The old names of persons have undergone much change, chiefly from the mistakes of southern clergymen who have ministered in the islands, and who have been anxious to substitute Christian names for heathen ones, as they deemed those which they found

current. Thus, Jarm or Bjarmi has become Jerome; Osla or Oslaf has been changed to Ursilla; Saemund is disguised as Simon, but even yet is pronounced Simmund; Thorvald, Tirval, and Taeder, have been confused and run into Theodore; while Geirsi, the diminutive of Geirhilda, has assumed the baptismal form of Grisella. Even Haki, the ancient Hakon, has been completely lost in Hercules. But Gutcher = grandfather, Ganfir = ghost, still preserve their old forms.

The personal pronouns in use are thus declined:—

	Singular.			Plural.		
	Nom.	Poss.	Obj.	Nom.	Poss.	Obj.
First Person,	I,	my, mine, mīnz,	me.	We,	wir, wirz,	wiz.
Second Person,	Dü,	dy, dine, dīnz,	dee.	Ye, You,	yur, yurz,	you.
Third Person,	He,	hiz,	him.	Dey,	der, derz,	dem.
	Shü,	her, herz,	her.			
	It,	itz,	it.			

The cardinal numerals have the following forms:—

1 een.	6 sax.	11 ilieven.	a dizzen.
2 twa.	7 sieven.	12 twal.	a score.
3 tree.	8 acht.	13 terteen.	a hunner.
4 fower.	9 nine.	20 twinty.	a tousan.
5 five.	10 ten.	30 terty.	a mylion.

The common speech of the present time in the islands is generally understood with ease by any Scotsman, but still words frequently occur not found south of the Pentland Firth, as the following specimens will show:—

Specimens of the Shetland Dialect.

I.—"Da laek o' yun I nivir saw, dey're rivin' da claes frae demsels laek onything. O boy! gaeng, gaeng!" Den midder strampit oot ower da door, in a reglar agle o' fedders an shüt, an' says shü, "Lowrie, gie me your jocktaleg. Mam an' I's been tearin' awa at the shicken-cock for guid kens hoo lang, tryin' ta twist his trapple, an' deil bit if he bü na as lively as ever he wiz, an' wallopin' da ould wuman laek stour." "Da heevins! wife,"

says faader, "I tocht mam an' you wiz for makin' me edder a weedow or an orphan! Haed ye no a wharrel?" "A wharrel! I tink dü's da grittest fule frae dis ta Skaw." Faader sat an clured a balt spot abune his lug in less dan a wharter o' a hoor, dan he rais and guid down ta da noust, an' I sat an' leuch till I sood a deëd, at da wye faader haed come oot paeching laek da ill helt. Da tüllie it da shicken-cock maed wi mam an' minnie, faader tocht wiz da twa wives trotlin' een anidder, and he tocht on-ly brucks o' dem wid be left."

The older words and forms in the foregoing are explained below:— **Da laek o' yun,** the like of that; **demsels,** themselves; **gaeng,** go (imperative); **strampit,** stepped; (stramp, intensive of stamp); **agle,** soiled condition, Ic. hagr, state, condition; **fedders,** feathers; **shüt,** soot; **Lowrie,** Laurence; **your,** modern for dy, thine; **deil bit if he bü na,** devil a bit if he be not; (bü is an old subjunctive form); **wiz,** was; **ould,** modern for *aald*; **stour,** dust, probably the ashes blown up by the commotion about an open hearth; **faader,** father; **mam,** mother; **tocht,** thought; **weedow,** widower; **wharrel, wharter,** quarrel, quarter, Wh for Qu; **dü's,** for dü is, thou art; **grittest,** greatest; **Skaw,** the extreme north point of Shetland; **clured,** scratched, Ic. klora, to scratch; **balt,** bald; **dan,** then; **noust,** place for boats when drawn up on shore; **leuch,** laughed; **wye,** way; **paeching,** panting; **da ill helt,** the ill-health, the evil one; **tüllie,** struggle, tulzie; **minnie,** grandma; **een anidder,** one another; **brucks,** broken portions, Ic. brot, fragment.

II.—Da Aald Man Compleens.

Der's Kirsty ta da gutteen aff,
An' Baabie till a place,
An' peerie Keety's a' 'at's left
At heem ta guide da baess.

An' noo auld Geordie Tamsin's oy
Is snuffin' efter hir;
Gude feth, it wid provok a sant,
An' set him in a birr.

E'en noo he's creepin' troo da yard,
He tinks I'm geen ta bed;
Sae help me, as I'se lay me staff
In splunters ower hiz heed.

Gutteen, gutting (of fish); **till,** to; **peerie,** small, a very characteristic Shetland word (confer French pire, worse); **a' 'at's,** all that is; **baess,** cattle (confer beeves, bé, Ic. bū); **oy,** grandchild; **troo,** through; **I'se,** I shall.

III.—Da Paets.

Drive da tushkar deep,
  Lift them, wan by wan,
Lay dem gently on da bank,
  Hael noo, in ye can.

Raiz dem ta der feet,
  Right afore da son,
Twa or tree tagither put,
  Wan can't stand alon.

Paets, peats; **tushkar,** torfskar, an instrument for cutting peats, Ic. torf, turf, and skera, cut; **wan,** one; **hael,** haul, go on; **in,** if; **ta,** to; **der,** their; **son,** sun.

IX.—*On the Glaciation of the West of Scotland.*

By Dugald Bell, F.G.S.

[Read before the Society, 24th January, 1894.]

(Plates VIII., IX., X.)

Two or three years ago I had the honour of reading a paper to this Society, entitled "The Great Winter," giving a summary of the evidence from which it appears that, at a comparatively recent period, glacial conditions, similar to those existing in Greenland at the present day, prevailed over a great part of what we now call the temperate zones. From this evidence it has been concluded that, at a time not very remote, nearly the whole area of the British Isles; the north of Europe generally, down to about 52°·N; and North America, as far south as the 40th parallel, were deeply covered by great continental sheets of land ice, nourished by immense snowfields on all the mountain ranges, and extending far out from these on every side. I also gave an outline of the leading theories which have been advanced to account for so great a change of climate as this implies, and of the more or less probable conclusions which have been arrived at regarding the antiquity and duration, and uniqueness or otherwise, of such a "Glacial Epoch." *

It may form an appropriate continuation of the paper referred to, if I now endeavour more particularly to *localise* the subject, and consider some of the traces which this great "Age of Ice" has left around us in our own immediate neighbourhood.

The Phenomena.

Briefly, these are the very general striations on the rock surfaces, always bearing away from the main tracts of elevation, and showing great uniformity of direction over particular districts; the smoothed and rounded knolls or *roches moutonnees;* the heaps of "till" or boulder clay, so conspicuous all over the lower grounds,

* *Proc.*, Vol. XXII., pp. 261-283.

with their abundant stony contents, the greater part of local origin, but also a considerable proportion derived from a distance; the "erratics," or perched blocks; and the mounds or ridges of what we may call at present "glacial *débris*," found in many localities. These all indicate a movement in this neighbourhood across the country by the central valley, from west to east, varying from north-west to south-east.

This, however, must not be taken as determining the direction of the movement all over the country, or in every part of it, which was the mistake that some of the earlier observers fell into. From the evidence in the central valley, they inferred a general movement from the north-west—a great "arctic current" from that direction, which swept over the whole country, and produced the effects under notice. But, as soon as it was seen that the ice-marks diverged in all directions from the main mountain ranges, the notion of the "north-west current" was discredited, and is now very generally abandoned.

Assuming that the phenomena just enumerated are so familia that there is no need to take up present time by a detailed description of them, and referring to the "Appendix" for any further particulars, I pass on to submit some considerations regarding—

THE AGENT—FLOATING ICE, OR LAND ICE.

I formerly gave some reasons for holding that these striated rock surfaces, rounded knolls, heaps of boulder clay, perched blocks, &c., are all due to the action of great sheets of land ice. But the notion of icebergs, or "floe-ice," or floating ice in some form, still lingers in some minds, and has lately been reproduced with so much authority in certain influential quarters,* that it may here be desirable briefly to recapitulate and reinforce some of these reasons against it. Of course, the probable existence of icebergs, or ice-floes, in the seas around a country covered with ice, is not denied; what is denied is, that by these means, or by ice in these forms, the effects under consideration, all over the surface of the country, or of any neighbouring country, could be produced.

To begin with: those straight uniform markings on the rock surfaces, and those *roches moutonnées*, are exactly similar to what

* See *Nineteenth Century*, February, 1894.

we see are produced by existing glaciers, and which, we may safely say, could not be the work of floating ice of any kind. For example, the striations are often seen to go sloping *uphill*, to cross ridges, and then continue at a lower level in the same direction on the other side. This evidently could not be done by bergs or ice-floes; these might grate on the summit of the ridge, but how could they rise to cross it, and then dip down to graze the rocks behind it at a lower level? This could only be done by a firm yet flexible agent, which completely encased the ridge from top to bottom, adapting itself approximately to all the inequalities of the surface, and moving on independently of these.*

Again, floating ice could not give its *local character* to the boulder clay: the stones that it carried would all be from a distance. It could not pick up any in its progress, nor could it impart to these stones any regular or well-defined striation bearing any relation to their form. [This alludes to the fact that a large proportion of the stones in the boulder clay, large and small, are distinctly striated in the line of their longer axis, as if they had been held fast and pushed forward in one position, the position of least resistance.] The fine clay also is evidently composed chiefly of the rubbings of the underlying rocks, and changes in colour and composition after passing from one set of strata to another, which, of course, could not be the case with droppings from floating ice. Further, if dropped from floating ice, the materials —such as fine mud, sand, gravel, stones, large and small—would undoubtedly be arranged by the ocean currents in a certain order according to their weight; in short, they would be *stratified*, instead of being, as they are in the boulder clay, indiscriminately mixed together.† They would also, unquestionably, be more or less interspersed with marine organisms, instead of being wholly

* A well-known instance of what is here referred to is the ridge at Garelochhead, with the rocky knolls near the village close behind it, down to the sea level, and along the shores of the loch, which are all beautifully striated in one direction, from north-north-west to south-south-east, manifestly by ice which passed over the ridge from Loch Long and down the Gareloch Valley. This instance convinced Charles Maclaren, more than forty years ago, that it must have been land ice.—"Select Writings," Vol. II., pp. 109-117.

† Croll: "Climate and Time."—"It is physically impossible that any deposit formed by icebergs could be wholly unstratified," p. 437. "Besides, how could the clay be derived from icebergs?" p. 284. See also Lyell, "Students' Elements," p. 155.

devoid of them (except in a few instances, where these have evidently been derived, and mixed up promiscuously with the clay, by the ice passing over a former sea-bed).

Next, with regard to the "perched blocks," it is to be noted that there is a very general correspondence between the position of their *longer axis* and the direction in which they have been transported.* Clearly, this could not be the case in regard to blocks dropped from icebergs; they would be left in *every possible* position; the more common, in all probability, being heavy end downward and light end upward, which is seldom, if ever, seen. Besides, these "erratics" are often in very singular positions — poised on detached summits or narrow ledges, on which it is impossible to believe they could have fallen or been left by a rocking mass of ice grounding in a shallowing current. Again, icebergs cannot move without *currents*, deep and strong, to carry them; and by no effort can we imagine such currents diverging from the various mountain centres to the localities where such boulders are now found.

Finally, the *degree of submergence* supposed and required to enable icebergs to carry boulders to these localities (between 2,000 and 3,000 feet has actually been suggested) would leave very little of the land above water—far too little to form snow-fields or ice sheets, or consequently icebergs, of any size; if, indeed, there would be any snow or ice at all (such submergence being distinctly favourable to mildness of climate) on the scattered groups of islets which would then be all that remained of our country.†

So much for icebergs and ice-floes, for though we have not always mentioned the latter, the same arguments apply almost literally to both.

MORAINES.

In passing from it I may mention, however, that the insufficiency of floating ice, in any form, to account for the phenomena

* This appears especially in the larger boulders, as in most of those enumerated in the Appendix—*e.g.*, at Inverbeg, Arden, Callendoun, Loch Goil, Kirn, Gourock, &c. In the Royal Society of Edinburgh Boulder Committee's "Reports," it is one of the points most frequently insisted upon, though all through these "Reports" the transport is generally attributed to icebergs!

† Lord Kelvin on "Geological Climate." *Trans. Geol. Soc. Glas.*, Vol. V.

may be clearly seen also, when we look at certain other features which I have only incidentally mentioned—namely, the lines and mounds of *débris* which occur in many parts of the country, chiefly near the openings of glens and valleys. These, there can be no doubt, are the "lateral" or "terminal moraines" left by the ice during its gradual retreat. Near Ardlui, at the top of Loch Lomond; at Row, on Gareloch; near Carrick Castle, on Loch Goil; at Balquidder and Lochearnhead; in the neighbourhood of Aberfoyle and the Lake of Menteith; at the mouth of Glen Messan, on the Holy Loch; and in Glencloy, Glenrosa, Benlister Glen, and others, in Arran, may be seen striking examples of such moraines, sometimes line within line of mounds, as perfect as if only recently left by the ice in its gradual melting away.

An interesting instance came under my observation a few years ago, near the mouth of Glen Fruin, Dumbartonshire. A well-marked line of glacial *débris*, composed of sand, gravel, striated stones, and scattered blocks of various kinds of West Highland rocks, extends there in a direction transverse to the glen, and curves gradually uphill from 300 to fully 700 feet above the sea. I take it to be the terminal moraine of a small ice sheet that lingered in this glen and clung to the hill here long after the main body of ice had disappeared.* (See M, Plate VIII.)

In every one of these cases it is perfectly evident that floating ice could not have been the producing agent; and the rough, undressed, unstratified condition of the mounds, as a whole—their very existence in their present form,—shows that they have never been subjected to the action of the sea, either while they were being deposited or at any subsequent time.

We conclude, then, that the agent which produced the phenomena under consideration was not floating, but land ice, and that, excepting the local moraines which were laid down during its gradual diminution, all these phenomena indicate great, confluent, wide-spreading ice sheets, such as invest polar lands at the present day.

The Great Mass of the Ice.

It is obvious that the ice must have been in very great mass to have produced the effects referred to, to have marked the rocks with such general and uniform striations, at all levels from the

* *Trans. Geol. Soc. Glas.*, Vol. IX., p. 345.

Glen Fruin Moraine — Illustrating Mr. Bell's Paper.

Maguire, Macdonald & Co. Lith^rs Glasgow.

sea up to between 2,000 and 3,000 feet, to have laid down over all the lower tracts of the country those great and abundant heaps of boulder clay, thickly charged with stones, from both near and distant localities, and to have transported those perched blocks and left them where they are now found. To take an illustration from these last-mentioned phenomena: Mr. Charles Maclaren, long ago, noted a boulder of mica schist, weighing eight or ten tons, resting on "a pretty steep declivity" of the Pentland Hills, about 1,000 feet above the sea;* and Dr. Croll and Mr. James Bennie found striæ and patches of boulder clay, containing fragments of West Highland rocks, on the same range, some 500 or 600 feet higher.† The nearest locality from which such travelled rocks could have come is 50 or 60 miles distant. At the Pentlands, the thickness of the ice which left such deposits could scarcely have been less than 1,800 feet. Sixty miles westward, nearer its origin, assuming a surface slope of 15 to 20 feet per mile, it must have been very nearly 3,000 feet in thickness. And this is quite in harmony with all the local evidences. On Ben Lomond, as I formerly mentioned, the ice marks can be traced from the very edge of the loch, where they are beautifully seen at Rowardennan, up to a height of 2,250 feet, not *descending* the mountain, as originating there, but passing *across* the face of it, as proceeding from a more northernly source, doubtless the group of high mountains and the elevated tracts bordering on Glen Falloch. As Loch Lomond, near Tarbet, is fully 600 feet in depth, the thickness of the ice at this point must have been, at least, close on 3,000 feet. And it would obviously require ice of about this thickness to produce the striations long ago observed by Colonel Imrie on the tops of the Campsie hills,‡ and to overflow the Kilpatrick and Renfrewshire hills, as it can be shown to have done.

This is also quite in harmony with what has been observed in other parts of the country. Mr. Jamieson states that Schiehallion, in Perthshire, 3,500 feet high, is marked near the top as well on its flanks, "not by ice flowing down the sides of the hill tself but by ice pressing over it from the north." On the top of another isolated hill, called Morven, about 3,000 feet high, near

* "Geology of Fife and the Lothians," p. 301; "Select Writings," Vol. II., p. 115.

† "Climate and Time," p. 440. "*Proc. Roy. Phys. Soc. Edin.*," 1883.

‡ *Proc. Royal Soc. Edin.*, Vol. III.

Ballater, Aberdeenshire, the same observer found "granite boulders unlike the rock of the hill, and apparently derived from the mountains to the west." "Again," he continues "on the highest water-sheds of the Ochils, at about 2,000 feet, I found pieces of mica-schist which seem to have come from the Grampian Hills to the north-west, showing that the transporting agent had overflowed even the highest parts of the Ochil range. On the Perthshire hills, between Blair Athol and Dunkeld, I found ice-worn surfaces of rocks on the tops of hills at elevations of 2,200 feet, as if caused by ice pressing over them from the north-west, and transporting boulders at even greater heights." *

I need not take up time by showing that in other lands, as in Norway and North America, proofs abound that the ice at one time attained still greater dimensions.

Its Prevailing Direction.

Indeed, one proof of the great mass of the ice is the fact of its having taken this eastward direction, which the particulars we have been mentioning conclusively show. Why did it take this direction at all—up the Clyde valley and across the country to the German Ocean,—instead of proceeding, as it might be expected to do, down the Firth of Clyde, and so out to sea? The answer undoubtedly is that the ice so filled and blocked what is now the Firth of Clyde that it could not *all* find egress in that direction. Much of it undoubtedly did so—the ice from the western Cowals, issuing from Loch Striven, Loch Ridden and the Kyles of Bute, and coalescing with that from Loch Fyne and Arran on the one hand, and from the Ayr and Galloway hills on the other, filled what is now the firth from side to side, in a solid mass more than 2,000 feet in thickness, and passed right over Bute, the two Cumbraes, and Ailsa Craig in its progress. But a very large portion or division of the ice stream, being thus barred from egress in that direction, found an outlet by the central valley, the irregularities or slight acclivities in which were as nothing to it, and so made its way *eastward* to the sea. Such were its dimensions when at its maximum, that the minor ranges of hills overlooking the valley formed no impediments to its progress.

Those who wish to study one proof of this should examine the hills around Kilmalcolm, and observe there the hard knolls of trap

* *Quar. Jour. Geol. Soc.*, Vol. XXI.

smoothed and rounded, and beautifully striated with fine straight lines bearing directly from the openings of Loch Long and the Holy Loch. And numerous boulders of quartz and schist scattered over that trappean district tell the same tale. They show plainly the mass of the ice, and the persistency of its eastward direction at this point. They prove that the ice from the opposite mountain region moved straight across the present channel of the Clyde and over this part of the Renfrewshire hills, thus completely barring the opening of the firth, so far as any possible passage of ice southward or westward from this neighbourhood was concerned. And this is confirmed by what may be observed along the eastern margin of the same ice sheet—namely, that which occupied the Gareloch. If the firth had been clear and open for the passage of ice southward from that loch, we should undoubtedly have seen the marks of it, as it approached the mouth of the loch, bending round and pointing away down the channel. Instead of this, at Roseneath on the one side, and Row and Ardencaple on the other, we see the striæ maintaining a strong south-east direction, pointing partly *up* the channel to the hills behind Greenock and Port-Glasgow. Not only so, but on the hillside above Row, at a height of about 500 feet, the striæ point still more to the east, and, if prolonged, carry the eye straight to the northern face of Benbowie, about half-way between Helensburgh and Loch Lomond; and in one or two of the sandstone quarries in that neighbourhood, striæ have been observed with a still more decided easterly direction. In short, it is quite clear that the Gareloch ice, having no outlet to the south or west, and being still pressed eastwards, passed on partly into the Loch Lomond valley, and partly up the present channel of the Clyde, by Cardross and Dumbarton.*

Proofs of this general easterly motion of the ice abound all over the district. At Garelochhead, as already noted, owing doubtless to the influx, immediately opposite, of the Loch Goil ice from the north-west, an immense body of the ice passed south-south-east, across the ridge or col there (about 300 feet high), into the Gareloch valley, and, also, still further east, over the adjoining

* A good corroboration of this may be seen near Langbank, opposite Dumbarton, in a well-striated surface of trap, the striæ clearly pointing up the present channel. This proves, with what has been already stated, that the "Clyde ice" in great force took this easterly direction, and that the "Loch Lomond ice," not being of sufficient magnitude to impede or prevent it, shared in the same easterly movement.

higher col (about 600 feet), into Glen Fruin. This latter col is, as distinctly as the former, simply an old glacier channel, strewn with boulders, and covered with great mounds of *débris*, while the hills on both sides of it, and on the eastern sides especially of the glen, are strongly glaciated to a great height, and bear innumerable boulders that have undoubtedly been derived from the mountains to the north-west.*

But for the most impressive evidence I know of the prevailing easterly trend of the great ice sheet in this part of the Clyde district, I must again refer to Ben Lomond. I have stated that ice marks are visible on the mountain up to a height of about 2,250 feet. That is remarkable in itself, but still more astonishing is the fact that there they actually *slant across* the shoulder of the mountain in a south-east direction, into the Forth valley on the other side. Only the peak of Ben Lomond seems at one time to have risen above the prevailing ice sheet like one of those rocky points called "nunataks," which Nansen has so vividly described as rising above the otherwise universal ice in Greenland. Yet it is obvious that, even then, the main mass of the ice in the neighbourhood was situated to the west, and that the predominant pressure was from that direction. In conformity with this, all the evidence goes to show that, by every side glen from the west, the ice came pressing into the Loch Lomond valley, imparting to the ice stream there a general easterly tendency, causing it to act with great force on the hills on that side, as on Ben Lomond itself, on the hills between Loch Lomond and Balmaha, and on the ridge of old red conglomerate there; and ultimately causing the great mass of it to pass on by Strathendrick, Killearn, and Strathblane, and along the Campsie Hills into the central valley.†

While on this point, I may add that it seems very certain, or rather self-evident, that the ice from the west (always speaking of this particular district), which was demonstrably the more powerful at the period of maximum glaciation, would continue to be so all through, till glacial conditions came to a close. If, during

* Maclaren observed that the hills on the eastern side of the Gareloch especially, showed "dressed surfaces;" the same is the case also, very strikingly, in Glen Fruin.

† If the Loch Lomond ice had not this general easterly trend, we may ask, Whence came the ice that striated the Campsie Hills and the Strathblane valley, and left such abundant fragments of West Highland rocks all along the foot of the Campsie and Fintry Hills? And what of Mr. Jack's "shelly gravel," which the ice carried up from the bed of Loch Lomond?

the period of maximum glaciation, the Loch Lomond ice, for instance, was constantly being pressed eastwards by the preponderating mass of the western ice, is there any reason to suppose that at a later period, when the ice both in that loch and in the western lochs was diminishing, the Loch Lomond ice would become relatively more powerful than the western ice, and so spread, or turn aside, at any part of its course, to the westward? I can see no reason—not the shadow of a reason—to think so. On the contrary, it appears to me certain that the Loch Lomond ice would diminish more rapidly than the western ice, the latter being nearer to its source, and that source an area of maximum precipitation then as now.*

* Mr. Jamieson has clearly shown that the great snow fields, or centres of ice action, in glacial times were just the areas of maximum precipitation in the present day, the mountain tracts of the country—with or without any change of absolute level—being the same. These observations bear directly on a theory that has been adopted by some friends, after having had their attention directed to the Glen Fruin moraine, that this remarkable line of glacial debris is the "lateral moraine" of a "spur" of the Loch Lomond glacier, which turned aside westwards at this point (nearly at a right angle to the main body from which it proceeded), and extended across this neck of land towards Helensburgh. What is supposed to favour this theory is a similar ridge, or, at all events, a series of detached mounds, extending up the eastern side of Benbowie, above Banachra. Now, with all deference to the powers of others in this respect, we find ourselves quite unable to imagine a "spur" of ice descending the hill at Shantron, on the one side, from 700 to 300 feet, then turning round and ascending the hill at Banachra, on the other, till it regained very nearly its former elevation! Keeping by prosaic facts, we find that glaciers do not throw out such "spurs" at all; their nature is to go straight forward, unless deflected by some insuperable obstacle, which is here not apparent. Hence they often cross lateral valleys like a wall of ice, blocking them up, and causing lakes, as any one who has studied the "Parallel Roads," or been in Switzerland, ought to know. Besides, as we have endeavoured to show, there was "no thoroughfare this way:" it was blocked and barred by the western ice. A brilliant suggestion has, indeed, been made that the Clyde ice may have prevented the egress of the Loch Lomond glacier by Dumbarton, and so forced it—at this widest part of the loch, and with great straths extending near it to the east—to turn aside westward to Helensburgh. That is to say, the Clyde ice was powerful enough to prevent the whole mass of the Loch Lomond glacier from going straight on by Dumbarton, and yet was not powerful enough to prevent a "spur" of it from turning aside by Helensburgh into the very heart of the Clyde ice! On a par with this is another suggestion, that the Kilmalcolm Hills were glaciated from the south-east instead of from the north-west—that is to say, *towards* the mountains, instead of *away from* them!

THE OLD SNOW LINE.

Some difficulty may still be felt as to the *cause* of the prevailing easterly trend of the ice in this district, though there can be no doubt as to the *fact*—the striations, and boulder clay, and scattered boulders all over the central valley abundantly proving it. Let us try to understand it a little more fully.

There can be no doubt that the mountainous region immediately surrounding the upper parts of Loch Lomond, Loch Long, and Loch Fyne, was the great nursery and feeding-ground of the ice sheets which occupied in force the channels of these lochs, and debouched thereby in such magnitude on the central valley. When we go a little farther north and north-east in that region, towards the Black Mount and Rannoch district, we find the ice there had several other great channels of egress—by Glen Orchy, Glen Strae, and Loch Awe to the south-west; by Glen Etive and Loch Etive, Glencoe, and Loch Leven to the west; by Glen Dochart, Loch Earn, Loch Tay, and Loch Rannoch to the East. Therefore, though we must conceive all this region of the South-west Highlands to have been an immense reservoir of snow and ice, it is only this south-eastern part of it, more immediately adjacent to the Clyde valley, with which we have to deal.

Now, it is admitted that the general configuration of the land during the glacial period was much the same as at present,—the only, or main, difference being a lowering of the average temperature (however caused) which brought down the snow line to, say, 3,000 or 3,500 feet lower than at present. As the temperature falls about one degree for every 300 feet of ascent, this would represent approximately a lowering of the average temperature by about 10°. Such a diminution in the heat supply would bring the climate of Northern Norway down to the latitude of Southern Germany; so that in the words of Dr. Jas. Geikie, "no change in the relative elevation of the land would be required; increased precipitation, accompanied by a general lowering of the snow line for 3,000 or 3,500 feet, would suffice to reintroduce the Ice Age."*

In these circumstances, the line of perpetual snow in this country would in some places nearly approach the sea level, or, speaking generally, might be a few hundred feet above it. Assuming it to have been, during a great part of the glacial epoch, somewhat less than 1,000 feet above the sea, then all these hilly tracts in the

* "Fragments of Earth Lore," p. 232.

west would form an immense snow field and nursery of glaciers down to that line. Hence it is a mistake to suppose that where a few high mountains are situated, there the glaciers would necessarily be the largest. It is not a few detached mountains, however high, that are required, so much as an extent of ground *sufficiently high* to form a permanent snow field; and there, under suitable conditions, as Dr. Russell Wallace has recently shown, the accumulation of snow and ice might be simply enormous.* Thus we find that some very high detached mountains, instead of being centres of glacial action, were themselves glaciated by the powerful ice sheets proceeding from the main snow fields of the country. In short, if at any given point we ascertain in what direction lay the nearest extensive land area of over 1,000 feet in height, we may be quite certain that from *that* direction the main force and pressure of the ice were exerted during the glacial period.

Now, such a tract lies partly to the west of Loch Lomond, and still more largely to the west of Loch Long. That group of mountains near Arrochar and Loch Sloy, comprising Ben Arthur, Ben Crois, Ben Ime, Ben Vane, and Ben Voirlich, must have been a source of glacial action on a very large scale, for which Loch Long, no doubt, afforded the principal outlet, but which, there is good reason for saying, partly extended also into Loch Lomond. Then, farther south, between Loch Lomond and Loch Long—say, from Tarbet to Luss and Garelochhead—there is a tract averaging in great part not less than 2,000 feet, with a number of high hills, or mountains of the second class, between 2,200 and 2,400 feet in height. The like is true of that still larger area which extends west of Loch Long, and round Loch Goil, Loch Eck, and the Holy Loch—a very extensive region, largely averaging over 2,000 feet, and thickly studded with mountains, rising to 2,400, and in one instance over 2,700 feet in height. Such tracts would form great reservoirs of snow and ice, largely contributing to, and determining the direction of, the general ice flow. When we consider these facts, taken in connection with the brimful condition of Loch Fyne to the west, and of the whole Clyde basin to the south, we may more clearly see why, in this neighbourhood, the great movement and pressure of the ice must have been south-eastward and eastward, as all the evidences we have been reviewing prove and confirm.

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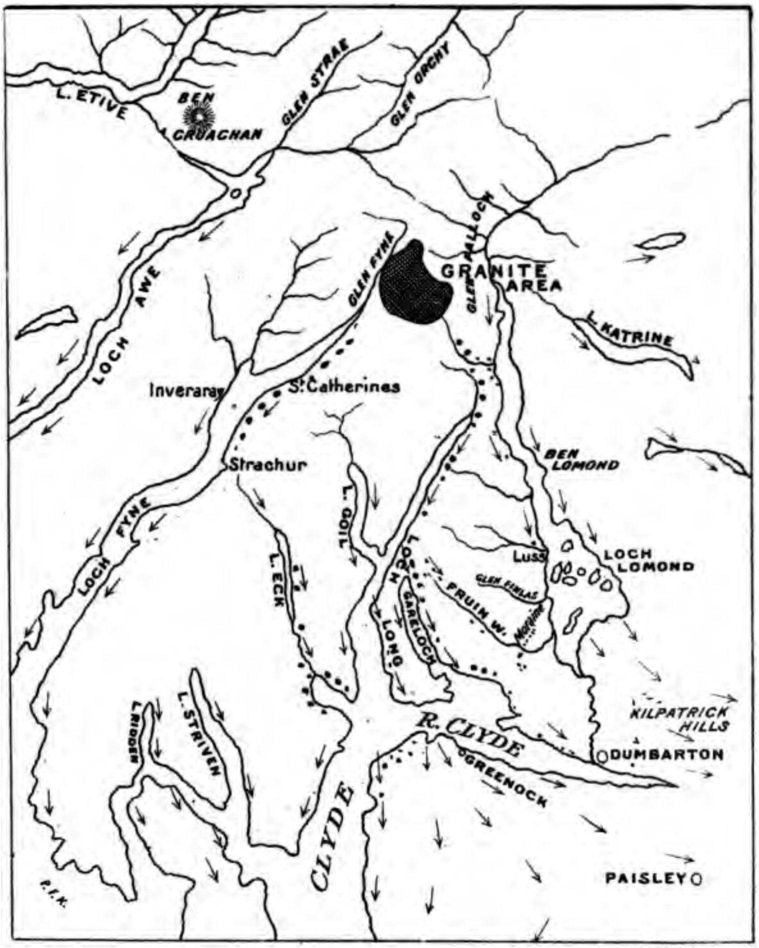
* *Fortnightly Review*, Nov., 1893.

THE GRANITE BOULDERS.

When we get at the true theory or explanation of any set of phenomena, it is always interesting to note how many particulars turn up, sometimes unexpectedly, to confirm it. We have seen that among the clearest indications of the course of the old ice sheet are those boulders of some easily-recognised type of rock, the origin or parent bed of which is known. In England, geologists have made admirable use of some rocks of this kind—such as the "Shap granite" and others,—by means of which they have been able to map out very distinctly many parts of the course of the old ice sheets. In Scotland we have as yet done less in this way, though we have a number of excellent "index rocks" in various parts of the country. One of these is furnished by the granite boulders which occur in the boulder clay around Glasgow, and in various other parts of the Clyde valley. There are two varieties of this rock—one, the more abundant, a rough, porphyritic granite, containing large flesh-coloured crystals of felspar; and the other, more compact and fine grained—both easily recognisable. It is evident to any one that the granite is not only a travelled stone, but that it must have come from a greater distance than perhaps any other variety of rock in the boulder clay around Glasgow. It has doubtless been derived, like the other varieties of rocks in the boulder clay, from some part of the mountains to the north-west, but as there is no such rock in any part of these mountains immediately adjacent to the Clyde valley, its exact parent-locality was for a long time in doubt. Mr. Smith, of Jordanhill, attributed these boulders to Ben Cruachan, but they do not correspond with the Ben Cruachan granite, and the whole trend of the glaciation of the district is opposed to the supposition of their having been transported from that quarter. Some years ago, struck with the great numbers of such boulders at St. Catherines, on Loch Fyne, and also at Arrochar, on Loch Long, I concluded that their true origin was almost certainly among the mountains to the north of these places. Ere I was able to test this surmise by a personal exploration of the district, it was fully confirmed by the appearance of a valuable paper by Messrs. Dakyn and Teall, of the Geological Survey, describing a granite tract of about twelve square miles which occurs between the upper part of Glen Fyne and Glen Falloch, but almost wholly on the Glen Fyne side of the watershed. The central and westward part of the area, towards Glen Fyne, is

SKETCH MAP_ ILLUSTRATING MR. BELL'S PAPER.



→ STRIÆ ⁝•• GRANITE BOULDERS

MACLURE, MACDONALD & CO. LITHRS GLASGOW.

occupied by a rough, light-grey, porphyritic granite, with "large crystals of orthoclase, measuring often two inches across." On the east, near the watershed, there is a small area of fine-grained granite, non-porphyritic, with some diorite. The authors make no allusion to the dispersal of boulders, their sole object being to exhibit the chemical and mineralogical proofs that we have in this area, the results of "the consolidation of a vast subterranean reservoir of molten rock." *

I have since spent a long summer day amid the solitudes of this mountainous region, where I found the granite *in situ*, and have no doubt of its being the true origin of the boulders in question. Their dispersion from it by the various channels in which they are found is quite in accordance with the known facts of the glaciation of the district.† (See Sketch Map, Plate IX.)

I have followed the course of many hundreds—perhaps I may say thousands—of these boulders in various directions. Down the eastern side of Loch Fyne on to Strachur, over by Loch Eck and the Holy Loch into the Firth of Clyde, and right across the Firth to the opposite shore at Gourock and the neighbourhood of the Cloch; and again, by Loch Sloy and Arrochar, down the eastern side of Loch Long, over into Gareloch (abundantly), and along its eastern shore, by Shandon and Row, to Helensburgh, to Ardmore, and on towards Cardross and Dumbarton; and, further, from Garelochhead over into Glen Fruin, in the upper part of which they are numerous, but become fewer down to the school-house, near which there are two or three, and at least two reach the "moraine." Some, also, are found behind Helensburgh and on the western side of Benbowie, as if left in process of transport from that direction.

They are met with very sparingly, if at all, in Glen Falloch, and, from the position of the granitic tract, it is evident that by far the greater number would be carried by Loch Fyne and Loch Long.

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* *Quar. Jour. Geol. Soc.*, Vol. XLVIII., p. 104.

† I have recently learned, by a reference kindly furnished by Mr Jamieson, of Ellon, that the late Mr. Hopkins, of the Royal and Geological Societies of London, indicated this locality as the origin of the boulders in question as long ago as 1850. Mr. Smith, however, in his well-known little volume of "Researches," published in 1862, makes no mention of this; and in Geological Maps published in 1861 and 1876, there is no indication of granite in that quarter, so that Mr. Hopkins' observations seem to have been very largely overlooked till now recalled by the researches of the Survey.

Further down, however, they begin to appear on the western side of Loch Lomond, but not very numerously, having apparently been brought in by some of the side glens. I found reason to conclude that a number had so come in from the direction of Loch Sloy, at Upper Inveruglas, and Mr. Hopkins thought that some had probably been carried across from Arrochar to Tarbet, as he remarked, "that direction of transport"—namely, from Loch Long to Loch Lomond "appears more consistent than the opposite one with the general direction of dispersion in that quarter."* This seems to be a most sound and just observation, worthy the attention of all who have been imagining other things. Certainly, in crossing from Tarbet, we find the number of granite boulders perceptibly increasing as we approach Arrochar, where they are abundant. I am not aware that any have been found along the lower part of Loch Lomond or in the Vale of Leven, but they occur on the hillside near Overtoun, to the east of Dumbarton, and in considerable numbers behind Dumbuck, apparently just where the Clyde ice in its eastward progress would impinge on the hills there. A few have also been found nearer Bowling, and at Bishopton, on the other side of the river, and so on into this part of the Clyde valley, where, it may be said, no considerable excavation can be carried on without some, at least, being brought to light. As a rule, they are smaller and more rounded the farther they are from their origin, which is quite consistent with the attrition they were almost certain to be subjected to in being conveyed by land ice.

Conclusion.

In recalling observations made during many years' wanderings over this part of the West of Scotland, other illustrations of the subject readily occur, on which I shall not at present enter. What I have laid before you may suffice to give those who have not hitherto bestowed much attention upon it some idea of the many interesting problems connected with this branch of inquiry. It may also serve to show, on a small scale, how alone a true theory in any part of it can be attained—namely, by patiently gathering the facts, placing them together, and weighing their import. Pursued in this method and spirit, one may venture to say there is no department of science which furnishes a more delightful exercise for both the observing and the reflecting powers than does Glacial Geology.

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* *Quar. Jour. Geol. Soc.*, Vol. VIII., p. 23.

APPENDIX.

A.—The Glacial Phenomena.

For the sake of reference, the following summary may here be given :—

(1) *The Boulder Clay* is full of stones of all sizes, large and small, confusedly mixed together. These stones are of various kinds, derived from sources near and remote. As a rule, those of a near origin are the more abundant. Some of the others have evidently been brought from considerable distances. They are mostly sub-angular, flat, or oblong, smoothed and polished chiefly on one side, with scratches or striæ in the line of their longer axis. The clay in which they are imbedded is usually abundant, and is chiefly local, derived from the immediately underlying rocks. In general, it is unstratified and unfossiliferous.

(2) *The Striations.*—The rock surfaces under the boulder clay usually show grooves or striæ bearing in the direction from which it is evident the stones have been transported. These markings are wonderfully straight and continuous in certain directions over a given district, and are to be seen sometimes even on vertical or overhanging faces of rock. Besides being striated, the rocky knolls are generally dome-shaped *(moutonnées)*, with a smooth, sloping side in the direction whence the abrading force acted, and a steeper or rougher side in the other. The striations and *roches moutonnées* radiate in various directions from the main mountain masses of the country.

(3) *Erratics, or Perched Blocks*, occur in many places, sometimes poised on narrow ledges, on which it is impossible that they could have remained from falling if they had got the least impetus. The striations upon them and the position of their longer axis generally correspond with the direction in which they were being moved, and with the striations on the neighbouring rocks. Some large blocks have been transported *across* broad and deep valleys, and to a higher level than their parent beds.

These particulars, we submit, are all inconsistent with the theory of floating ice, and point clearly to the action of land ice.

B.—Enumeration of Erratics, or Perched Blocks.

A few of the more notable in the central valley and our own neighbourhood may be mentioned :—

(1) There is the well-known instance described by Mr. Charles Maclaren, as referred to in the text, a block of mica-schist, weighing 8 or 10 tons, found on the Pentland Hills, about 1,000 feet above the sea, and 50 or 60 miles in a straight line south-east from the nearest rock of the same kind *in situ.* *

* "Geology of Fife and Lothians," p. 220.

(2) Near Kilsyth, there is a mica-schist boulder, 6 tons in weight, 1,250 feet above the sea, and distant about 30 miles, probably, in a similar direction from its parent bed.*

(3) On the North Hill of Campsie, there is a conglomerate boulder, about 7 tons in weight, 1,800 feet above the sea, the parent rock of which must be from 15 to 20 miles distant to north-west.†

(4) On the top of the conical hill of columnar basalt, called Dunglas Hill, in the centre of the Strathblane Valley, is a small boulder of mica-schist, which must have come from a distance of at least 20 miles in the same direction. Nearer the mountains, such instances of perched blocks increase in frequency and in size.

(5) On the side of Loch Lomond, above Inverbeg, opposite Rowardennan, a large oblong mass of mica-schist rests on the shoulder of the hill there, 1,020 feet above the sea.‡

(6) Nearer the south end of the loch, on the hill behind Arden, which is formed of old red conglomerate, a number of mica-schist boulders occur at a height of about 600 feet, the largest of which probably weighs fully 70 tons. (See Plate X., Fig. 1.)

(7) Further down the hill, near the old castle of Banachra, are two or three others, scarcely inferior in size.§

(8) A little further north, at the lower end of Glen Fruin, the Callendoun boulder, also of mica-schist, the largest in the district, estimated to weigh fully 240 tons, rests on the side of a sandstone ravine, about 200 feet above the sea. (See Plate X., Fig. 2.)

(9) On Ben Donach, Lochgoilhead, a large cubical block of the same kind stands on a grassy slope, far from any crag, at an elevation of some 900 feet above the sea.

(10) Near Carrick Castle, towards the lower end of Loch Goil, a well-rounded mass of gneissose schist is poised conspicuously on a projecting ridge of the hill, about 1,000 feet above the sea. An immense number of large blocks are strewn over the hillsides up to a still greater height in that neighbourhood.

(11) Near Callander, a large gneiss boulder, about 80 tons in weight, called "Samson's Putting Stone," rests on the conglomerate of Bochastle Hill, close to the edge of a steep cliff, between 300 and 400 feet above the valley.

If we come down to lower levels and along the present sea margin, the list might be indefinitely prolonged. The following, however, may be mentioned in addition:—

(12) The Peaton boulder, opposite Ardentinny, Loch Long: a large block of gneissose schist, 226 feet above the sea.

(13) The Rahane boulder, Gareloch: another large mass of schist, partially imbedded in a ravine, fully 200 feet above the sea.

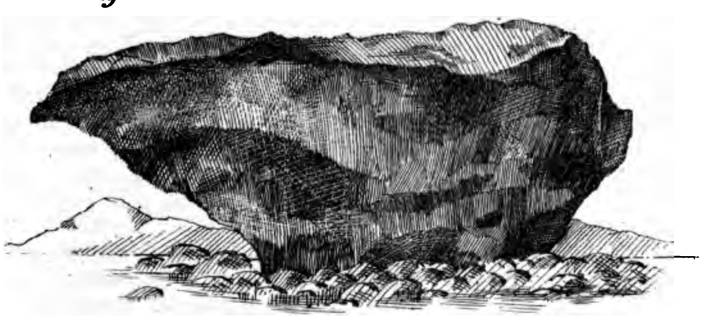
* "First Report, Boulder Com., Roy. Soc., Edin." † *Ibid.*

‡ *Trans. Geol. Soc. Glas.*, Vol. VII., p. 172. § *Ibid.*, Vol. VIII., p. 255.

BOULDERS — ILLUSTRATING MR. BELL'S PAPER.

S. E. *Fig. 1.* Arden Boulder. N. W.

E. S. E. *Fig. 2.* Callendoun Boulder. W. N. W.



S. S. E. *Fig. 3.* "Jim Crow" Boulder, Kirn. N. N. W.

MACLURE, MACDONALD & CO. LITHRS. GLASGOW.

(14) The Shandon boulder, on the shore, nearly opposite the gate of the "Hydro.," also mica-schist, weighing about 80 tons.

(15) The "Jim Crow Stone," on the shore, near Kirn: a large block of compact grey schist, resting on clay slate, with a long tapering end pointing out towards the firth. (See Plate X., Fig. 3.)

(16) The Gourock boulders. On the opposite or Gourock shore, from Kempock Point down to Lunderston Bay, below the Cloch, there are very many boulders, which may be mentioned together without being particularised. Some are of considerable size, and include many varieties of schist, &c., evidently derived from the mountains across the firth, there being no rocks of the same kind *in situ* on that side.

In nearly every one of these instances, particularly among the larger blocks, the longer axis coincides, as has been stated, with the direction in which the boulder had evidently been transported.

C.—THE GRANITE BOULDERS.

A few additional particulars may be given regarding the distribution of the granite boulders, particularly near the opening of the firth, as throwing light upon the movement of the ice sheet there. As stated, these boulders occur all along the pass from Loch Sloy down to Arrochar, where they are very numerous, and often of great size. They are found also on the hillside behind Arrochar, and for some distance in the cross valley there, becoming scarce towards Tarbet. At Garelochhead, and all the way down to Shandon and Row, they are very numerous. Only a few are found on the opposite side of the loch, chiefly near the top. About Helensburgh, a great many occur: one of considerable size on the shore at the west end, and several near Craigendoran at the east. Nearer Ardmore, they are more numerous; about forty, large and small, having been counted at that place. (Probably fewer have been broken up and lifted away there.) Behind Helensburgh, on the old Luss Road, and on the west side of Benbowie, several may be found. Near Cardross, and on towards Dumbarton, a few occur on the shore, and again, as noted, a number on the western face of the Kilpatricks, near Bowling. All this indicates a continuous line of deposition from Garelochhead to Bowling, unbroken by any influx from the east.

Again, in the upper part of Glen Fruin they are numerous, between fifty and sixty having been counted there in the dykes and on the hillsides. Lower down the glen they are not so numerous, but a few small ones have been dug out of the boulder clay about half-way down, and a finely-rounded one of some size is perched on a knoll about a mile above the schoolhouse. Near the schoolhouse, also, a few have been found, and then two or three on the "moraine"—always, so far as our observation goes, on the western or north-western side.*

* From all that has been stated it is perfectly evident that these Glen Fruin boulders came in by the head of the glen. And it must have been massive ice which brought them. Where, short of the "moraine," is it supposed this ice stopped, so as to allow the imaginary "spur" to come in?

At Gourock, finally, a considerable number have been found. From about half-a-mile below Kempock to Lunderston Bay, below the Cloch, between thirty and forty have been counted, some of considerable size. The ice sheet which carried these across the firth, whether from the Holy Loch or Loch Long (or, probably, the joint glacier from both), it is obvious must have effectually barred this part of the channel.

Many of the smaller boulders referred to, especially along the shores of Gareloch, have been built into dykes or the sea wall.

MORAINE MOUNDS, GLEN FRUIN.

X.—*On Sorghum Sugar Experiments in the United States.* By T. L. Patterson, F.C.S., F.I.C.

[Read before the Society, 7th February, 1894.]

Persistent attempts to extract sugar from sorghum in the United States during the last thirteen or fourteen years have directed attention to this Eastern plant, and invested it with new interest for the agriculturist and sugar-producer. Although the experiments hitherto recorded have not been satisfactory, failure has only stimulated its advocates to renewed effort, which must soon lead to success, or demonstrate, once for all, the complete unsuitability of sorghum for the production of sugar. The success of the beet-sugar industry must be credited with raising the expectations and inspiring the confidence of the sorghum grower, for it is said, in effect, "what has been done for beetroot can also be done for sorghum."

In 1795, Archard first obtained 6 per cent. of sugar from the beetroot, its presence therein having been demonstrated previously. Since that time the fostering care of Continental governments has not only enabled the beet-sugar industry to outlive the troubles and difficulties besetting its youth, but clothed it with prosperity, and established it as a permanent industry. With careful cultivation, the roots now grown yield, on an average, 15 per cent. of sugar, and, in favourable localities, as much as 17 and 18 per cent. So great, indeed, has this industry become, that 56 per cent. of the world's consumption is obtained from this source alone. Considering these facts, the sorghum grower can hardly be blamed if he holds optimistic views on the future of sorghum, and the large returns to invested capital which he expects it to yield.

Many difficulties, common to the introduction of new industries, have been experienced in the course of the experiments on sorghum growing and manufacture. The crop requires to be sown in March or April, and reaped in the end of August, in September, or beginning of October. But sufficient attention has not been given to the climate in which it is grown, for if cold weather sets in before the cones are ripe, its yield of sugar is greatly reduced;

and frost, we are told, ruins the crop. Farmers are not agreed regarding the most suitable manner, or the best method of cultivation. The cane is said to be the victim of foes which often continue their ravages during the entire period of growth, causing a continual bleeding, as it were, followed by fermentation, and, in some cases, complete inversion of the sugar into glucose. There is, besides, a small and variable yield of cones per acre, as also much trouble experienced in cleaning the stalks from leaves.

The manufacturer, on his part, has to contend with other difficulties which are not easily overcome, and not met with in working sugar cane. The percentage of sucrose has so far been very variable, and that of glucose has been much higher than it is in the sugar cane. The gummy extractive matters and organic acids are different, and present in larger quantity, requiring new and improved methods of treatment, which have yet to be discovered. Over and above these difficulties, the best method of juice extraction and concentration, and the most suitable machinery, have not yet been determined. But all these difficulties, as well as others, are each forming the subject of careful experiment and investigation in the States at the present time; and, whatever the result may be, there is no doubt that the mass of information gradually accumulating will materially add to our knowledge of the technology of sorghum, and, perhaps, also to that of the sugar cane.

Sorghum is a native of India, China, and Africa. There are many varieties—the chief being *sorghum halepense*, the Arabian millet, and *sorghum vulgare*, the Indian millet. As doora, it was one of the principal crops of the Pharaohs. Durra and guinea corn are Indian varieties. All are largely grown for fodder, and cattle are fond of them. *Sorghum vulgare* is often called the Chinese sugar cane. Dr. Royle, in his "Botany of the Himalayan Mountains," Vol. I., p. 419, speaks of another variety, *sorghum cernuum,* which is cultivated by the inhabitants of the Munnipore district, and forms the staff of life to these mountaineers, because one of the few articles of their agriculture.

Although so long known in the East, it would appear that sorghum has been little used for making sugar. This is not surprising in a country where the sugar cane grows so freely. In 1890, a writer in the *Indian Agriculturalist* * speaks of a sample

* *Sugar Cane*, 1890, pp. 301 and 343.

of sugar made from a variety of sorghum called "alapore jowar," and in a succeeding communication he describes the native method of manufacture. The juice, which is concentrated in iron boilers to the consistency of "rab" or syrup, is refined by a mucilage made from the roots of a well-known plant called "bhindy." The rab is stored in earthen vessels until December or January. The crystallised magma is then removed and placed in vats or pits made of woollen material, through which the syrup percolates. Over the mass are placed heaps of wet "sewal" (a well-known aquatic fern, growing spontaneously in all stagnant pools and streams). In about a week the upper layer becomes dry, when the sugar is scraped off. Another layer of wet sewal is laid on, and this process of purging is repeated as long as any sugar remains to operate upon. This method of refining is interesting, because it recalls the old "claying" process at one time used in Cuba, the West Indies, and other colonies. This process consisted in placing a layer of wet clay on the top of the sugar moulds, filled with the crystalline mass, which gave up its water to the top layer of sugar, with which it formed a comparatively pure solution. This solution percolated slowly through the mass in the mould, displacing the syrup which it contained, and leaving the sugar on the top comparatively dry and clean. The claying process had to be several times repeated before the contents of the mould were refined. A similar process, called "claying," was used in the old loaf-sugar industry, but the clay was made by mixing the top layer of the mould with water, or with a saturated solution of pure sugar.

In India the wet sewal performs the same function as the clay did in Cuba and the sugar solution in this country. It forms a solution of comparatively pure sugar on the top of the vat, by reason of the attached water, which, slowly percolating through the bottom layers, displaces the impure syrup and glutinous matters, leaving a layer of partially refined sugar.

Sorghum sugar seems to be produced in very small quantity in India, for Mr. Thiselton Dyer, Director of Kew Gardens, endeavoured to obtain a specimen for his museum, through the Secretary of State and the Agricultural Department of India, without success.

Syrup and a kind of sugar candy, with a fine flavour, are said to be made from *sorghum vulgare*, both in India and China; and syrup was the ultimate product of sorghum juice when first introduced into the United States.

We learn from a report of the United States Commissioner of Agriculture for the year 1878,* that Mr. Prince, of Flushing, Long Island, was the first to introduce the Chinese variety of sorghum. This was in 1853. It also stated that the "imphee," or African variety, was brought from Natal by an Englishman, Mr. Leonard Wray, in 1857. This gentleman declared that he had seen sugar made from more than one variety of these imphees, and expected to meet with signal success, and realise a large fortune in his operations in the States. As a matter of fact, says the Commissioner, he was entirely unsuccessful in being able to make sugar from the juices of any variety worked there. The first sugar is said to have been made in 1858 by a Wisconsin farmer from the Chinese sorghum. But, judging from the account given of the method of manufacture, it must have been very inferior, for "it took the appearance of dark New Orleans sugar or wet sand."

Sugar-making was not the purpose for which sorghum was introduced into the States: that was an afterthought. The plant would appear to have been useful for the fodder yielded by its leaves, and as food for cattle, swine, and poultry afforded by the abundance of seed which it bears. The juice, however, was expressed by very imperfect machinery, and utilised for making syrup. This syrup is said to be characterised by a fine amber colour and pleasant taste, so that it had a ready sale, and commanded a fair price in the market. Its manufacture has assumed considerable proportions, for we learn from statistics quoted by Dr. Collier in 1883,† that the following quantities of sorghum syrup were made in the United States during the years 1860, 1870, and 1880:—

1860,	40,657 tons.
1870,	96,687 ,,
1880,	171,350 ,,

—the quantity thus nearly doubling itself every ten years. The number of factories making this syrup in Kansas alone is said to have been about 2,000 to 2,500 in 1881; so that the syrup industry may be said to be well established in that State.

But the enterprise of "our American cousins" was not satisfied with mere syrup-making: they must make sugar too. The idea was not wholly absent from the minds of sorghum growers since the time of Wray's attempts in 1858 or 1859; but it only commenced

* *Sugar Cane*, 1879, p. 150. † *Ibid.*, 1884, p. 135.

to take a practical form about twenty years afterwards, or, say, in 1879, when a gentleman in Pennsylvania, Mr. F. L. Stewart, communicated an article to the United States Commissioner of Agriculture on "Maize and Sorghum as Sugar Plants."*

Mr. Stewart, having studied the question for some years, sets forth his conclusions with great confidence, and promises a successful future for sorghum sugar. The article is replete with particulars as to the varieties of cane to be grown, climate, soil, machinery, chemical treatment, &c., and concludes with the description and figure of a small mill suitable for crushing the cane and working up the juice.

A full description of Mr. Stewart's apparatus and methods of treating sorghum cane is given in an article by Lock and Newlands in their "Handbook on Sugar," p. 512. I may also refer those who take an interest in this subject to the same well-written article for information on the technology of sorghum sugar, and other details which would be out of place here.

Mr. Stewart found by analysis that sorghum stems contain 12 per cent. of all sugars and 22 per cent. of other solid matter, while sugar cane contained 14 to 18 per cent. and 10 per cent., respectively. The juice of sorghum held 13½ per cent. of all sugars and 1·7 per cent. of other organic matter and salts, against 16 to 18 per cent. and only ·38 to ·8 per cent., respectively, in the sugar cane. He estimated the yield of syrup as 100 to 350 gallons, or about 2 tons per acre, and says that 40 tons of Chinese cane have been grown on one acre! Good mills, he tells us, are capable of extracting 70 to 80 per cent. of the juice which the plant contains. Different varieties of sorghum at different periods of their growth have yielded him 7 to 16 per cent. of sucrose, and ·78 to 3·53 per cent. of glucose. The variety which yielded the most sugar was the Chinese imphee, the upper and middle joints of which contained 16·19 and 2·13 per cent. of sucrose and glucose, respectively.

Mr. Stewart was fully aware of the chief obstacles to sugar-making from this source, for he remarks that "the two principal causes of failure in all the attempts hitherto made to produce sugar from sorghum are—first, the presence in the juice, when in the best condition, of an almost constant quantity of glucose; and, second, the uniform presence of peculiar protein and amylaceous com-

* *Sugar Cane*, Vol. XI., p. 158.

pounds, which distinguish these from other sugar-producing plants; consequently the extraction of sugar from sorghum is a problem involving entirely new conditions." But he must have thought the problem very easily solved, for he concludes his paper in the following words, namely :—" Ordinary good judgment on the part of the operator, attention to details, a knowledge of the main principles involved, and a degree of practical skill, easily acquired, are all that are necessary to give this new business a rapid and permanent success." As a matter of fact, the problem has proved to be much more difficult of solution than Mr. Stewart imagined, for the elimination of these organic compounds has given the American growers and chemists much trouble, and baffled their ingenuity until now.

The publication of this paper with all the authority of the Department of Agriculture must have created a profound sensation, and induced in the minds of growers visions of an "El Dorado" in sorghum. For the idea of sugar-making took hold, and soon capitalists were found willing to invest considerable sums in the erection of suitable factories in the districts which seemed to grow the cane best; consequently extensive operations were started for growing sorghum and extracting the sugar. Several varieties were now in use. That which promised the best results, and which was first utilised for sugar-making, was the early amber, so called from the colour of its seed, and its habit of coming to maturity a few weeks earlier than the others. But many new varieties have since been introduced, with more or less success.

Great things were predicted for the "new industry," as it was called. One or two of the factories, after the first year's work, professed to make a small profit, while others showed a loss. The losses were easily accounted for by the unfavourable weather, the unsuitable character of the machinery, the inexperience of the operatives, the want of proper knowledge of the method of treating the juice, &c., &c.

Crushing machinery, similar to that in use for the sugar cane, was first used for sorghum, but it was very light, and did not extract half the juice. Then double crushing, with maceration, was tried, and gave better results. Still the yield of sugar was small and it was resolved to try the diffusion process, so successfully employed in the Continental beetroot industry. New factories were started, and old ones refitted with complete diffusion plants, and enthusiasts went so far as to import German

operatives to work it. But even with the best technical skill and appliances, the industry was unsuccessful, and one factory after another was closed, or it dropped into liquidation.

Congress has all along encouraged the production of sugar in the States from any source, and from time to time it has voted grants for conducting experiments and researches having reference to the sugar industry and the raw material used in the manufacture of sugar. And some of the States more immediately concerned have offered substantial bounties to the producer who embarked in the industry. New Jersey and Massachusetts, for instance, offered a dollar per ton on all the sorghum used in the production of sugar; and, in addition, New Jersey offered a further bounty of one cent per pound on every pound of sugar made from sorghum. These bounties also applied to the beet industry. But the Government help and encouragement thus afforded were unable, as we have seen, to keep the factories open.

Dr. Collier, formerly Chemist to the U. S. Department of Agriculture, took a different view of the situation. In an address which he delivered in 1883 to the National Grange at Washington he describes the experiments of the last few years as having been successful; and quotes, from what he calls a "cloud of witnesses," a number of newspaper paragraphs and journalistic opinions, in support of the strong statements as to the alleged profitableness of the industry and as to the golden future which he predicted for it. He mentions 10 tons as an average crop of sorghum per acre; and 6 to 8 lbs. of sugar as the yield to be expected from a gallon of syrup. But he is careful not to commit himself to the yield of syrup from a ton of cane which may be considered an average from the very varying results which he adduces. So confident is he, however, as to the future of this industry, that he thinks "it is possible to produce sugar from sorghum with greater profit than from sugar cane in Cuba, even under the most favourable conditions." Dr. Collier, I should say, obtained a patent shortly before this, and he was now trying to reap a harvest of royalties. "It may appear," he goes on to say, "somewhat hazardous to venture any prediction; but I think that within a decade we shall produce our own sugar, and by 1900 shall export sorghum sugàr to Europe." It is now ten years since this prediction was made, and I need hardly say that the sorghum industry has not yet passed the experimental stage; far less is it in a position to supply the wants of the United States.

This extraordinary address had the effect of creating a new "boom" in sorghum, for in the next year or two more capital was forthcoming and new factories were established, which worked a season or more, and dropped out of existence when the capital was exhausted. Had Dr. Collier confined himself to experiments on the improvement and development of the cane, so as to combine the excellencies of several varieties with the prospect of surpassing any now known, as suggested for consideration in his own address, or otherwise experimented with the plant or its product, giving the results of his labours to the world year by year as he proceeded, he would have been performing legitimate and useful work. But when a scientific man steps from the standpoint of experimental facts into the arena of pure speculation and prophecy, he degrades his profession, leads many believers to ruin, and brings discredit on science.

A very interesting and comprehensive report on the "sorghum industry of the United States" was prepared by Mr. C. Hardinge, for Sir L. S. S. West, then our representative at Washington, and forwarded by him to our Foreign Office, under date 5th October, 1886. It is printed in full in the *Sugar Cane*, Vol. XIX., p. 20. The report was evidently obtained in reply to a request for information by Mr. T. Dyer, of Kew Gardens, who took exception to some statements of sorghum experimenters. It was stated that "only after the seed of any variety of sorghum is quite mature that the maximum of sugar in the stalks is attained, so that there is nothing to prevent the securing of both the maximum of seed and the maximum of sugar from the (same) crop of sorghum." This Mr. Dyer declares to be "quite incomprehensible as a scientific deduction from facts." But the Commissioner of Agriculture assures the reporter "that it has been definitely settled, both by experiment and practice, that a full crop of seed is not only compatible with a large yield of sugar, but that full maturity is necessary for the largest yield." This statement is not borne out by the results quoted; further experiments seem necessary to prove it. But a firm belief in the possibility of reaping both crops has been the ever-present hope of the sorghum planter.

We learn from the report that Dr. Peter Collier had retired from the position of Chemist to the Department of Agriculture, and that the experiments on the culture of sorghum had been under the care of Dr. H. Wiley for the past few years (since 1881).

The extent of the "industry" at this time may be gathered

from the statement that the entire production of marketable sugar from sorghum and maize during the previous ten years did not exceed 2,232 tons. Statistics are given for the year 1884 of three well-managed factories, all under the care of experts. One is at Hutchinson, another at Stirling, and a third at Ottawa, all in the State of Kansas. The figures, I have no doubt, fairly represent the progress made up to that time. The following table is an extract from them, in the order I have named :—

	I.	II.	III.
Tons of cane per acre,	7·6	7·1	6·1
Bushels of seed per acre,	15	15·30	2·7
Percentage of juice extracted,	40	50·60	40
Pounds of sugar per ton of cane,	47	24	30
Gallons of syrup per ton of cane,	7	10·5	5
Commenced milling,	22nd Aug.	1st Sept.	1st Sept.
Closed milling,	30th Oct.	31st Oct.	6th Nov.

These figures represent, perhaps, the first reliable results to be met with in the literature of the subject. They are very low compared with those quoted by Mr. Stewart and Dr. Collier, and show what a poor thing sorghum then was in comparison with the sugar cane. A yield of 7½ tons of sorghum per acre is surely a very light crop, when the sugar cane yields on an average 30 tons. The seed is very variable, being 2·7 bushels in Ottawa against 30 in Stirling, the latter being equal to the yield of wheat per acre in this country. The average juice expressed is less than half that contained in the plant, and shows how unsuitable crushing machinery is for obtaining it. Of course, the percentage of sugar must be low when the juice is low, but it would require a yield four to six times greater to make sorghum equal to sugar cane. The sugar to a large extent is lost in the syrup, the abnormal yield of which has been the great difficulty from the beginning. Sorghum, as we have seen, contains so many melassegenic bodies that the sugar could not be crystallised out.

Partial results are reported from other factories; but in 1886, when Mr. Hardinge wrote, only two remained in operation, and one of these was under the care of Dr. Wiley, Chemist to the

Department of Agriculture. About 450 tons of sorghum sugar were made in 1885, and, comparing this production with the United States consumption, Mr. Hardinge truly remarks that "the fact is patent to all that this industry has not yet assumed actual commercial importance." "The difficulties inherent in the plant," says Dr. Wiley, "have been constantly undervalued. By taking the mean of several seasons as a basis of computation, it can now be said that the juices of sorghum as they come from the mill do not contain over 10 per cent. of sucrose, while the percentage of other solids in solution is at least four, thus rendering the working of such a juice one of extreme difficulty."

Experiments made in 1885 by Dr. Wiley on the application of the diffusion process to sorghum, and the treatment of the juice or extract by the carbonatation process with lime and carbonic acid are referred to in this report with encouraging results. In this way he obtained 98 per cent. of the sugar in the cane, and a yield of 95 lbs. of sugar per ton of cane worked. These are the results of experiments on the small scale, but they are of considerable technical interest, for they show that it is possible to increase the yield of sugar by improved methods of treating the cane.

There is much interesting matter for the careful reader in the report of Mr. Hardinge, to which I cannot further refer. Those who wish more information should consult the report itself.

In the year 1887, by way of encouraging the flagging industry and stimulating sorghum growers to renewed effort, the State of Kansas offered a bounty of two cents per lb., equal to 9s. 4d. per cwt., for the next five years, for every pound of sugar made in the State from sorghum or beet. In that year 105 tons of sugar were made, and so earned a bounty of £940.

In his report for 1888 to the United States Department of Agriculture, Dr. Wiley contents himself with a *resumé* of the leading experiments on sorghum culture since 1879 in the States of Minnesota, Illinois, Kansas, Tennessee, and New Jersey (all of which were failures), and the result of a sorghum competition which took place in 1882. In that year the Commissioner of Agriculture, finding that the crop of the previous year under the care of the Department showed a heavy loss, resolved not to repeat the experiment; but offered, instead, a premium of $1,200 each, for the best ten returns sent in by independent manufacturers. Competitors had to comply with certain conditions, which required them to furnish complete information regarding the growth of the

cane, the manufacture of the sugar, and the labour required. We are not informed how many competitors entered the lists on that occasion, but there must have been more than ten; yet the total amount of sugar made was only 52 tons, and the total premium paid by the Department was $12,000, or rather over 5d. per lb.

Thus it is evident that individual States and the United States Government have done all that governing bodies could do to encourage this industry. They have provided and maintained a special sub-department and a special staff of chemists for making experiments on sorghum and beet, from which useful information is communicated to growers annually. They have declared special bounties in favour of manufacturers of sorghum and beet,—in some cases, as we have seen, to the extent of 9s. 4d. per cwt. Besides this, there is an import duty of about 3s. per cwt. on all sugar above No. 16 Dutch standard brought into the country—a tax from which, of course, the home producers of sugar from cane, sorghum, and beet are exempt. But notwithstanding these advantages, the sorghum sugar manufacturer was unable to "keep his head above water."

Discouraging as the results are, they were insufficient to damp the ardour of the sorghum enthusiasts. These gentlemen were persuaded that all the experiments hitherto made had only proved the unsuitability for the sorghum industry of the apparatus and methods ordinarily used in the cane sugar and beet sugar industries. They were satisfied that sorghum would yield a workable amount of sugar if they could only get it out. Experimenters, they say, had never attempted to grapple with the main difficulties of the sorghum manufacture—namely, the large percentage of gummy and albuminous matters and glucose which exist in this plant in very much larger proportions than in either the sugar cane or sugar beet. They were convinced that experiments made in this direction, and experiments made by crossing different varieties of sorghum, and selecting seed from the plant which gave the largest yield of sugar, accompanied by the minimum amount of objectionable organic matters, would yet lead to good and profitable results. It was also suggested that attention should be paid to the canes which were found most suitable for the climate, and, of these, the species or varieties which came to maturity earliest in the season.

These suggestions were acknowledged as cogent by the Department of Agriculture, for Dr. Wiley now set himself to study them,

and in his report in 1892 he gives full particulars of the experiments made. Before proceeding to the consideration of these, however, it is necessary we should look for a moment at the progress made in 1890, communicated by Dr. Wiley in his report for 1891.*

In his communication to Sir L. S. S. West, already referred to, Mr. Hardinge draws attention to some experiments made in 1885, in which the carbonatation process gave encouraging results with sorghum. Returning to these experiments, Mr. Wiley now tells us that they were repeated on the large scale in 1886, at the Government Station of Fort Scott, in Kansas, where a large diffusion plant had previously been erected. The diffused juice was treated with lime in sufficient quantity to form compounds with the organic impurities, and afterwards precipitated by injecting a current of carbonic acid gas. "The result," he says, "was entirely successful in respect of the yield of sugar; but on account of the blackening of the molasses, which was at that time a valuable by-product, it met with no favour from sorghum sugar manufacturers, but, on the contrary, was condemned by them as being unsuitable for the purpose." Some 205 tons of sugar were thus made at Fort Scott in 1886. The samples of sugar and syrup on the table are from the products of these experiments.

Mr. Wiley now tried to precipitate the crystallisable sugar in the juice by means of lime, according to the Steffin process. He also tried to destroy the reducing sugars and glucose by boiling the juice with lime; neither of which processes gave satisfactory results. The gummy bodies and other carbo-hydrates were not removed, or only partially so. Abandoning these, he turned his attention to alcohol, which is known to be a good precipitant of such bodies. Here he met with more success, for he was able to separate two per cent. of them.

The method of extracting and treating the juice was the same as that which had already been found to yield the largest amount of syrup—namely, the diffusion process. The diffused juice was treated in much the same way as sugar-cane juice, and concentrated in a vacuum pan until it contained about 50 per cent. of solid matter. At this stage he adds an equal volume of alcohol of 80 per cent., and separates the precipitated melassegenic bodies by passing the syrup through a filter press. The filtered syrup is then boiled, and crystallised in the usual way. Alcohol is not

* *Sugar Cane*, Vol. XXIV., p. 13.

added at an earlier stage, because much more would be required, and its cost must be kept down to a minimum. This process is said to double the yield of sugar, and it would seem that 568 tons were thus made at three experimental stations during 1890.

The partial success which attended Dr. Wiley's experiments in 1890 induced him to continue on the same lines during 1891, and we learn from his report for 1892, which is the last one published,* that "the chief advantage of the new process is not so much the increased yield of sugar as the ease with which the material can be passed through the factory." Dr. Wiley refers to a difficulty in the alcohol process which is at once apparent. "Under the present system of internal revenue," he says, "it would be very difficult to devise a system of regulations which would at the same time secure the revenue against fraud and allow the manufacturer sufficient freedom of action for the success of his work." But Dr. Wiley is equal to the emergency, and proposes the amendment of the revenue laws, in such a way that this could be done; and also that the manufacturer should be permitted to distil his own alcohol from the waste sugary residues of the process, and not be called to account for any loss which may occur. Even supposing Dr. Wiley succeeded in bringing about such a change, I fear his next difficulty—and one more formidable, perhaps, than freeing sorghum from melassegenic impurities—would be that of keeping men sober to work it.

The experiments of 1891 were conducted with the view of the direct comparison of the ordinary and the alcohol process of refining. The care and promptitude which characterised the working enabled Dr. Wiley to obtain a much greater yield of sugar by both methods than that hitherto obtained by sorghum manufacturers. The alcohol process yields better first sugars, having good colour and high polarisation. The average of these was 92·6 per cent. by the alcohol process, as compared with 84·7 by the ordinary process. Some difficulties, which Dr. Wiley considers incidental to the working of a new process with old or imperfect machinery, cropped up in the course of these experiments. There was, for instance, considerable loss of sugar in the filter presses, the construction of which is not considered suitable for the alcohol process. There were others at the still, and by entrainment in the vacuum pan. These losses at times amounted

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* *Sugar Cane*, Vol. XXV., p. 10.

to 40 lbs. and upwards of sucrose per ton of cane, but it is believed they would either be avoided or reduced to a minimum by working on the large scale. Certain varieties of cane were found to furnish juices that are much more manageable than others, and, notwithstanding a lower sucrose content, yield a larger proportion of sugar.

Perhaps the most valuable feature of this 1892 report consists in the description of the agricultural experiments, two series of which were in progress—one by the Agricultural Department, and the other by a private individual—for the determination of the best variety of sorghum for the propagation of seed, and the extent to which each varies in its sugar content. Such experiments had often been suggested, but had not previously been undertaken, except, perhaps, in a very limited and unmethodical manner. Had this course been pursued at an earlier stage, and prosecuted in a thoroughly scientific spirit before attempting to make sugar, it is highly probable that the most suitable variety of sorghum for climate and cultivation would have been settled before now, and much time and capital would have been saved. But it is easy to be wise after the event, when it has been abundantly proved that the sorghum experimenters began at the wrong end. In these circumstances it is satisfactory to find that the Agricultural Department adopted the only course left open to them, and started anew at the beginning; so that we have reason to hope that the experiments in progress and those yet to be made will result in furnishing this most desirable information.

The Government experiments on the culture of sorghum were carried out at Stirling, in Kansas, where a similar series had been in progress the year before. The magnitude of the work may be gathered from the total number of analyses made, which was over 100,000. The total number of single canes individually examined was 26,634. Of these, 13,946 contained 15 per cent. and over of sucrose in their juice; the rest, 12,688, failed to reach the standard of 15 per cent., and were rejected. Of the samples which reached the standard, 5,905 contained between 15 and 16 per cent. of sucrose; 5,296, from 16 to 17 per cent.; 2,550, from 17 to 18 per cent.; 1,727, from 18 to 19 per cent.; and 23 contained over 19 per cent.

The second series of experiments, we are told in the report referred to, were made in Louisiana by Mr. W. J. Thompson, during 1889, 1890, and 1891, without Government aid; but only the experiments of 1891 are referred to. Mr. Thompson had a

two-fold object in view—namely, to find the cane which would yield the largest percentage of sugar, and at the same time come to maturity after the crushing season for sugar cane was over, so that the same machinery might be utilised for working it up. He finds that, amongst the striking peculiarities of sorghum cane, is its extreme susceptibility to variation of weather and of soil; and that for any variety of sorghum grown in Louisiana no definite length of time for maturing the plant can be even approximately assigned. For the same variety grown in two seasons, or planted at different dates in the same season, the period may vary from three to six weeks. This fact, says Mr. Thompson, "is one which for the present sets at naught any attempt to arrange two or more plantings which shall follow each other with any reasonable regularity in date of ripening."

Mr. Thompson's experiments on the yield of sugar from different sorghums give promise of excellent results, and agree well with those obtained by the United States Government in Kansas. He planted sixteen plats with different varieties of sorghum—one-half on 28th March, and the other on 28th June, 1891. As the canes came to maturity, single ones were cut from each plat, and individually submitted to analysis. The results are tabulated, and record the number of canes examined in each variety, with the percentage of sucrose in the juice, and quotient of purity of the three best of each plat, as well as the percentage of canes whose purity reached 77 per cent., and whose sucrose content was over 16 per cent. The plats planted in June are shown to be inferior to those planted in March. The following table is condensed from Mr. Thompson's tables, and gives the figures for the six best varieties in the March series:—

VARIETIES OF SORGHUM.	Canes examined.	Per cent. of Sucrose in Juice.	Quotient of Purity.	Per cent. of Canes 77 per cent. of purity or over.	Per cent. of Canes yielding juice of 16 per cent. Sucrose or over.
Early Orange, - -	70	16·9	81·0	32·86	18·57
Link's Hybrid, - -	110	18·5	82·6	33·64	23·36
Collier's, - - -	95	19·2	83·6	44·21	44·21
Ubehlana, - -	42	17·6	77·7	9·52	23·81
Planter's Friend, -	114	20·1	83·0	31·58	39·47
Coleman Cane, - -	80	19·9	82·6	32·50	36·25

These results are considered to be very satisfactory, for the percentage of sucrose in some of the single canes far exceeded that reached by the sugar cane grown in the same locality. Compared with the figures given by Mr. Stewart in 1879, already quoted, there certainly is a marked improvement in the sugar content of sorghum. But the table also shows that the quotient of purity is very much below that of the sugar cane, the average yield from the juice of which may be taken at 18½ per cent. of sucrose, with a quotient of purity of 90 per cent.

Mr. Thompson has approached this difficult subject in a scientific spirit, and, as far as they go, he has conducted his experiments with great care. He refrains from making statements as to weights of cane, seed, &c., per acre, preferring rather to concentrate his attention on the search for the variety of sorghum which will yield the highest percentage of sugar, leaving all other matters for future investigation.

One acre of land in the West Indies will yield, on an average, about 35 tons of sugar cane, and 2 to 2½ tons of sugar. The yield is less in the States and other places, whose climate is not so favourable for its growth, while in such countries as Java, Queensland, and Cuba, it is often much more. Whether sorghum will ever approach this out-turn is still an open question, but the improved yield of sugar recorded in the latest experiments, it must be admitted, is sufficient encouragement to warrant the United States Government in continuing them. Great credit is due to the Government for what it has already done, and all interested in our own sugar trade will wish success to the experiments now in progress. For should the States succeed in growing their own sugar—whether from sugar cane, sorghum, or beet,—the whole production of the West Indies, which nearly all goes there, would have to find a market in this country, to the great advantage of the consumer here. It is just possible that, in the long run, perseverance may lead to success; that, by careful selection and hybridation, attention to sowing, cultivating, and harvesting the cane, &c., a sorghum may be developed capable of yielding sugar of the same purity as the sugar cane, and one, too, which is as free from melassegenic impurities, and which will be as amenable to treatment for the extraction of its sugar, as the sugar cane or sugar beet. But until this is accomplished, there is no prospect of the manufacture of sorghum sugar establishing itself as a permanent industry in the United States.

THE SPECIMENS.

Early Amber Sorghum,—The stalk is about 12 feet long, including the seed-head. It is the variety which was first used for sugar-making, in 1879-80.

Honduras Sorghum.—This is a thick, very tall variety, something like the sugar cane. It seems to grow to a height of 15 or 16 feet, but it does not appear to be regarded with much favour as a sugar producer.

Orange Sorghum.—There are at least three varieties of this sorghum in cultivation, which were tested by Mr. Thompson. They grow about 10 to 12 feet high. The "early orange" yielded the purest juice, and the largest percentage of canes whose quotient of purity was over 77 per cent., and whose sucrose content was over 16 per cent. The "improved orange" is very similar to the "early orange;" while the variety known as the "late orange" contained juice having a higher percentage of sucrose with a higher quotient of purity; but only 15 per cent. of the canes examined came up to the standard of 77 per cent. purity and 16 per cent. sucrose.

Link's Hybrid Sorghum grows about 12 feet high, including the seed-head. It was one of the varieties experimented on by Mr. Thompson, and by the Government Department of Agriculture in Kansas. The former obtained 33·64 per cent. of canes whose purity was over 77 per cent., and 23·36 per cent. whose sucrose content was over 16 per cent., while the latter obtained a few canes with a much higher quotient of purity, bringing the average up to 35·09, but only 21·05 per cent. of canes contained 16 per cent. of sucrose in their juice. The two results are very close, and show that little difference is to be expected between canes grown in Kansas and others grown in Louisiana, about eight or nine degrees further south.

The seed-heads are, I regret to say, not named, but they show that a large crop may be expected when the cane is grown for seed alone.

Seed.—Six varieties are on the table—namely, Early Amber, Orange, Link's Hybrid, White Mammoth, White African, and Liberian.

I cannot say precisely where the specimens of cane and seed were grown, but it was in the neighbourhood of Fort Scott, Kansas, where was situated a private sorghum sugar company, as well as a Government experimental station, in 1886, when these

specimens were sent to this country. The sugar and syrup samples are from Fort Scott. The syrup contains a large quantity of crystallised glucose. The following is the analysis of the sugar made by Mr. J. M'Glashan:—

No. 1 is evidently the product from the diffused juice, after treatment with lime and carbonic acid; while No. 2 is obtained from No. 1 by washing with water in the centrifugal. The polarisation of No. 1 is very similar to that obtained by Dr. Wiley in 1891—namely, 83·9 and 84·7 per cent., respectively.

	No. I.	No. II.
Sucrose, - - - - - - -	83·90	97·80
Glucose, - - - . - - -	8·72	1·11
Other organic matters, - - - -	1·68	·69
Ash, - - - - - - - -	1·35	·25
Water, - - - - - - - -	4·35	·15
	100·00	100·00
Net Sugar by coefficients, 1 and 5,* - -	68·43	95·44

No. 1 analysis shows that this sugar contains a very large percentage of melassegenic bodies, which reduce it to the category of the crude sugars of India and China, such as jaggery or taal, though it has a very much better colour, and resembles Cuba muscovado in appearance.

No. 2 analysis shows that No. 1 sample can be refined, but I fear washing with water must be a rather expensive way of doing it.

I have only to add that I am indebted to my friend, Mr. James Hutton, 203 West George Street, Glasgow, for placing these fine specimens at my disposal. I hope by and by to present them to the Greenock Museum for preservation.

* These figures are multiplied for glucose and ash. One part of each prevents the crystallisation of one and five parts, respectively, of sucrose. In this way the net sugar is calculated. It represents the yield in pure sugar which would be obtained were the sugar refined to loaf sugar and molasses.

XI.—*The Glasgow Building Regulations Act (1892).*

By GEORGE W. BARRAS, Writer, Glasgow.

[Read before the Architectural Section, 19th February, 1894.]

THIS Act deals with matters which are decidedly of public importance, but which do not get from the public the consideration they deserve. The Act is the latest of the series of enactments affecting the City of Glasgow in its formation, sanitation, and improvement. Since 1844 the sanitary condition of the city has been receiving the attention of the authorities, but before 1862 no Act existed for properly regulating the erection and alterations of buildings.

In 1862 a general Act for Scotland was passed, giving limited powers, and in the same year Glasgow had an Act for itself passed for five years. In 1866 the Glasgow Police Act was passed, and has become so well known as to render any detailed reference to it unnecessary. The parts affecting buildings, streets, drains, &c., are *21* to *24*, comprising Sections CCLXXIII. to CCCXLIII. Assuming that they are generally known, I shall endeavour to explain the most important alterations of them made by the 1892 Act. These may be shortly generalised as relating to free space, heights of buildings and apartments, widths of streets and openings, formation of courts or hollow squares, drainage, ventilation, foundations, and sanitary details.

It is now generally admitted that two great causes of mortality in this and other large cities are (1) diseases of the lungs and (2) zymotic diseases. The city authorities in 1875 had their attention directed to the evil effects resulting from the occupation of tenements built on objectionable plans, with relation to width of streets and open spaces adjoining. It was proposed to get the powers of the 1866 Act extended, and a committee was appointed by the Police Commissioners. This committee met often and long, and took from January, 1875, to February, 1876, to formulate their opinions, after much care, attention, and anxiety.

In February, 1876, a deputation waited on the then Home Secretary, with a view to obtain further powers, but this official was of opinion that the points raised affected not only Glasgow but the whole of Scotland; and instead of promising to bring in an Act, suggested that the object aimed at might be attained by the preparation of the necessary regulations in the form of a Provisional Order.

The committee proceeded to follow out this suggestion, and, after meeting from time to time, reported in March, 1878, certain suggestions, alterations, and amendments, the object of which was, as stated by the city, to control, in an adequate and satisfactory manner, the erection and alteration of buildings, so as to secure sufficient free space externally and internally, and sufficient light, drainage, and ventilation, in connection therewith. An inquiry was ordered, and was held in February, 1879, before the late Sheriff Clark, and took the form of a case for the city's propositions being stated and opposed by (1) the Associations of Landlords and House Factors; (2) the Institute of Architects; and (3) the Faculty of Procurators and several adjoining landowners. Much evidence was adduced, and the Sheriff visited the places of interest. His report to the Home Office was a qualified one, so far as approval of the whole of the provisions was concerned. The Home Office asked the city to amend its propositions, as suggested by the Sheriff, but, instead of so doing, it was, in April, 1879, agreed to withdraw them. Matters rested thus till the 1892 Act was passed; but it may be better, perhaps, in order to lead up to the 1892 Act, to state generally what was proposed in 1879.

The most important proposition related to free space. Clause 370 of the 1866 Act enacts that the free space for air and light in connection with sleeping apartments shall be three-fourths of the height of the wall fronting them. By the 1862 Act one-half was enacted. It appears that what the city intended to be enacted by the 1866 Act was that the space of three-fourths should be opposite each tenement, and not, as has been held by the Supreme Court in Allan *v.* Whyte, 1890 (18 R. 332), that it may be shared with the property opposite—that is to say, what was meant was that a four-storey tenement, 45 feet in height, should have for itself a free space of 30 feet, and not that this free space of 30 feet could be divided between two tenements. This defect as to intention does not appear to be remedied by the

Glasgow Act of 1892; but the Burgh Police (Scotland) Act of 1892 (Section 170) provides that, subject to the discretion of the Dean of Guild Courts, under Section 167, if a dwelling-house be only partially ventilated from an adjoining street, the open space (three-fourths) directly attached thereto must belong to the owner of the dwelling-house.

At the 1879 inquiry the argument was used that this free space of three-fourths opposite each tenement was necessary for light and ventilation, and for air and solum space. By spreading the population over a wider area, contagious diseases, chest affections, and deaths of infants were largely avoided. It was stated that 44 per cent. of the Glasgow houses consisted of dwellings of one and two apartments, and 11 per cent. above three. Disease existed more than to double the extent in densely-populated districts. It was admitted that there may not be an utter want of ventilation in hollow squares, but it was contended that they were not healthy. The next point brought up was as to the height of apartments, and the minimum of 10 feet was proposed, attics being excepted. Then passages were to be 5 feet wide, but it was conceded that where a tenement was of two storeys only, and there was no back tenement, 4 feet width would do. The cubic contents of the apartments were to be increased, and the drains and foundations to be improved; and another great point was that, in cases where existing buildings were taken down, or, being decayed or burned, had to be rebuilt, they were to be under the new regulations.

The main grounds of objection were that vested interests would be disturbed, and the value of existing securities would be reduced, for which no compensation was provided; that the city's position of giving compensation only where the improvements were for public convenience, or for beautifying the city, was unfair; that the Master of Works was vested with too much power, his right position being to see the Act enforced, and not to have power to order what he thought best; that the free space was sufficient, if *pro indiviso* and not exclusive to each property; that the result would be an increase of rents, resulting in the working people either having to take less food or have less clothing in order to pay their rents, or requiring to go to smaller houses, the houses being small enough already; that the present buildings would not voluntarily be improved; and that the cubic space provided sufficient ventilation apart from the height of ceilings—a

properly-ventilated room with an eight-feet ceiling being better than a badly-ventilated one with a ten-feet ceiling.

Several important witnesses gave evidence at the inquiry, and the Sheriff in his report stated that the general scope of the Provisional Order was sound, but that important changes in details were necessary—such as, that there must be adequate provision for compensation, the inability to restore present buildings without compensation being really a confiscation of property; and that a ten-feet minimum height of ceiling had not been proved to be absolutely necessary. He also reported that much improvement was required in the sanitary condition of the city, and the Provisional Order in this line was good; and that hollow squares were unhealthy, and better ventilation would be had by avoiding them.

As already stated, this Provisional Order was the last attempt by the city to introduce changes as to buildings, &c., till 1892. The 1892 Act is in some respects a modification of the proposed Provisional Order. It may be of interest at this stage to state that neither under the 1866 Act nor the 1892 Act is there a proper definition of a building. Glasgow is somewhat exceptional in this respect, and a recent illustration of the defect was given in a case where a huge boarding was erected in Sauchiehall Street: the Court of Appeal held that the city had no power to order it to come down, as it was not a building within the meaning of the Act. (See Malcolm *v.* Lang, 1892, 29 S.L.R. 617.)

The first important section of the 1892 Act provides that the Act shall apply to additions and alterations on new or existing buildings, as well as to new buildings. This is also dealt with under Section 20 of the Glasgow Police (Amendment) Act of 1890 (53 and 54 Vict., cap. ccxxi.). Formerly where alterations were wholly internal, no application to the Dean of Guild Court was necessary for approval of plans, &c. This section, however, although inconvenient in a few cases, will, as a general rule, prove beneficial. Section 6 provides that all applications to the Dean of Guild Court shall be depending processes till the Master of Works reports on the completion of work. Under by-law 56, notice of the completion is to be given to the Master of Works at least three days before any part of a building is occupied.

I may here state that, at the 1879 inquiry, grave objections were stated against the Dean of Guild Court as it was then constituted, and some of them were not unreasonable—one of

which being that the Master of Works and other officials had the ear of the bench too much; in fact, it has been said that the court was really the Master of Works. It can be easily understood how a Lord Dean, not fully knowing the details of the court or his own powers, and not sitting for any reasonable length of time, relies, to a great extent, on his officials. It seems that the Dean has pretty much absolute power in his own court, subject, of course, to appeal to the Court of Session, and that his brethren in council, or the "liners," as they are called, have only advisory powers. The Dean has his legal assessor to keep him right on points of law, but it might be better to have a permanent Dean appointed on the principle of fitness for office, and not, as at present, on honorary grounds, and selected from the Merchants' House. The Dean of Guild Court has not been altered in its constitution since 1606 or 1607, and it will be recognised that such a time-honoured institution will not be readily revolutionised. The burgesses elect the Dean and four liners, and the Trades' House elect other four. These meet once a year, and elect a clerk and an assessor. It might be better to give the liners a vote along with the Dean in Dean of Guild cases, but, meantime, we must take the court as we find it; and where dissatisfaction as to its judgments exists, appeal to Court of Session is available.

The Act next provides, following on Section 368 of the 1866 Act, that succeeding owners are to take up the original petitioner's position and liabilities; that the consent of the local authority must first be had in cases of buildings for noxious trades; that the Master of Works may, at any stage of buildings, inspect them; and in cases where he or the Police Commissioners go to any expense for doing anything for which they have powers, they are to be entitled to recover such summarily by a motion before the court in depending processes.

Section 11 raises a legal question as to making the cost of works and incidental expenses done by the Commissioners on any buildings, on the failure of the builder to carry out the same, a real and preferable burden, which, of course, not only affects the owners, but is transmitted to each owner as affecting the land itself. A wise proviso is added that such real liens are to be recorded, so that purchasers or lenders of the subjects may have some notice thereof.

The next section provides for cases where owners desire to alter the work or material after their plans have passed the court, and

lays the duty of proving the necessity for the alterations on the owners. Then the Master of Works has, subject to the court's review, to test the strength of the materials to be used. The powers of the Dean of Guild, under Section 291 of 1866 Act, *re* public streets, are extended to private streets. Formerly the Master of Works had the power over private streets, and it is an improvement to give the Dean of Guild the power. The Act further provides that, for the public convenience, the Police Commissioners have power to acquire land and rights of way for suitable accesses to new streets by cross streets, or otherwise to provide through or cross communication from one street to another. Although it is not in the section provided that suitable compensation be given in such cases, the Act otherwise provides for it, and, subject to such, it will be admitted that these powers may be for the public advantage.

The Act next deals with the question of through ventilation and hollow squares. Where streets are designed in the form of a parallelogram, or so as to enclose a space of back ground, the plans must, except where the back space is large, show an opening of 15 feet in width from street to street, which opening is to be unbuilt on from the height of 15 feet upwards. This is not to apply to cases where the buildings are not to be used as dwelling-houses, or where the court is otherwise satisfied as to ventilation. This enactment is meant for cases where streets have been formed, but no buildings erected. It raises the question as to whether this 15-feet width is absolutely necessary, and whether, assuming more ventilation is required, the space is the best way to provide for the same. Much difference of opinion on this point exists. It is thought that where there are pends and open closes through the buildings, these provide sufficient ventilation. One point will be admitted—namely, that this opening or space, although possibly providing more current and distribution or change of air, will not provide better air or atmosphere than what exists in the particular locality. The obvious aim of the authorities is to let out of the square the bad air coming from the houses, and let the air be changed oftener. While admitting the reasonableness of the aim, it has yet to be established that the 15-feet width will really fulfil the object in such a way as to warrant leaving the width.

In cases where buildings have already been erected so as to enclose back ground, but the whole of the ground has not been

built on, the Dean of Guild Court is not to pass plans for the erection of buildings completing the square unless provision be made for the 15-feet width by the owners of the land, except where the court is otherwise satisfied as to through ventilation. Failing agreement among these owners, in cases where the land is owned by more than one, as to the proportions in which they shall contribute in money or land towards the formation of the opening, the court is to fix the same, and is also to fix the equitable sum of compensation, if any, to be paid by the Police Commissioners to such owners as may thereby sustain loss and damage. The question of compensation was one which Sheriff Clark reported as necessary for consideration in most cases of disturbance, so that confiscation, or its equivalent, might be avoided. It will be generally admitted that where, for the public benefit, an owner has a limited use of his ground, he should, in respect of his vested interest, get a fair compensation. The discussion of the principle of vested interest forms no part of this paper; but if vested interest exists at all, it exists as to land. It is, of course, true that owners who have been fortunate enough to possess ground in or adjacent to a large city are enriched through the rise of value of their ground, and this through no effort or merit of theirs. This has been popularly called "unearned increment," but it does not touch the principle of using any one's land for public advantage, in which case compensation ought to be paid by the public.

Where a plot of ground forming a square on which dwelling-houses are built or to be built is owned by different parties, and the contribution of the opening is borne among them, the necessity for compensation does not exist to the same extent; but still the principle is there. The Act provides that, where buildings are to be erected, and are to form part of a square, the owners of the part of the ground not required for the opening have to contribute in money or land towards the formation of the opening. This is to prevent the cost of the opening falling on one and not on another owner. Any other way would manifestly be unfair, for owners in the middle part of a square would have nothing to do with the opening, which would fall on the owner of the corner plot. The size of squares exempted is a square containing 1,800 square yards, and of 90 feet minimum width; and where the buildings are not higher than three storeys, the size is 1,400 square yards, with 65 feet of minimum width.

Following on Section 368 of the Act of 1866, the Act provides for barricades and hoardings being satisfactory, and having proper footpaths, and being removed within a reasonable time. Then, in cases of the assemblage of large numbers of persons, where platforms, balconies, &c., are to be used, the same are to be constructed to the satisfaction of the Master of Works. The penalty of contravention of this provision is £50. This is a wise and useful section. The collapse of platforms, &c., is not unknown, and is frequently accompanied with loss of life or injury to person. The temptation of not securing temporary erections, and of putting them up cheaply and hurriedly, is great, and a too stringent watch or check against such cannot be kept. A person may draw a large sum of money on a public occasion where a platform is required, and he often takes risks of the erection serving the purpose; but the risk of danger is much greater, and it is quite proper that some authority should have a right to examine the erection.

The Act next provides for the formation and repair of streets, and of sewers and drains, and provides that no building shall be erected fronting any private street until a common sewer be constructed. This provision is not always followed. Where the city requires a street to be rounded off, the Commissioners are to make compensation for any loss which may thereby be sustained.

Section 32 alters the 1866 Act so far as regards the definitions of the heights of buildings; but the whole of the section as it originally stood was not passed into law. What has been omitted was a provision that no warehouse or tenement to be erected should enclose more than 300,000 cubic feet of space, or should exceed the dimensions of 80 feet in length and height and 120 feet in depth. The Glasgow Rate and Salvage Association of the Fire Insurance Offices desired the city to make the maximum cubic space 216,000 feet, and 60 feet in height, depth, and length, as in London. The association contended that this was necessary for keeping down fires, and it requested that, if the proposals could not be agreed to, the provision in the draft Bill should be maintained. But the Act has neither, and it must, therefore, be assumed that this is the result of compromise with intending objectors. The section, as it stands, provides that the free space required shall be measured as from the floor of the apartment to the ceiling of the highest habitable room, or to where the roof of the building rests upon the wall, whichever is the higher of the two. Under the 1866 Act the building was measured from

the floor of the apartment to the roof of the building. The effect of this alteration will be at once seen : it is to secure that the free space of three-fourths opposite buildings, provided for by Section 370 of the 1866 Act, shall include the height of apartments near the roof; and thus, where there are to be apartments with ceilings near the roof, and above the walls of the buildings, both the higher and lower apartments will have as much free space as possible.

The question of Free Space is the next point dealt with in the Act. Section 33 is, however, chiefly explanatory of Section 370 of the 1866 Act. To be explicit as to the 1892 Act, it is necessary to refer again to the 1866 Act, under which, as already stated, it is required that the free space be three-fourths of the height of the wall, and that one-third of the height of the apartment be above the level of the street or court. This free space is measured in a straight line at right angles to the plane of the window, and Section 372 provides that the free space need not apply to the following cases :—(1) to an apartment in a corner tenement wholly *above* the street level, if the tenement does not extend more than 50 feet along the narrowest street; (2) to an apartment *under* the street level, provided there be an open space along the whole length of the apartment between it and the street, which is as deep as the floor of the apartment, and is as broad as the portion of the height of such apartment below the level of the street; and (3) to certain minor cases.

The 1892 Act defines that the free space under the 1866 Act shall mean space upwards and outwards beyond any obstructions from overhanging balconies, and the same free space is not to be available for any other sleeping apartment, the window of which is not on the same plane, unless the window overlooks a street. This latter provision is not to apply to (1) the reconstruction of houses, say, after a fire, which at present comply with Section 370 of the 1866 Act; (2) self-contained houses; and (3) to the back windows of a corner tenement, provided that there be left a through opening from the street to the back ground, 10 feet wide, and open from the height of 15 feet upwards. Should there be two windows to one apartment, it is sufficient if the Act be followed so far as one is concerned. As under the 1866 Act the city's intention was held not to have been sufficiently expressed in one respect, so, under the 1892 Act, has it been also held that the city has again come short of giving sufficient expression to what was intended. It was meant by the 1892 Act to amend the

1866 Act in some of the exempted cases under Section 372, and to provide that the back windows of tenements should have the free space as implied by the 1892 Act; but the Court of Session has held, in Raeside *v.* Whyte, 13th June, 1892 (not reported), that Section 372 is not repealed or modified by the 1892 Act, which is simply explanatory thereof. In this case the Master of Works lodged objections to certain plans, on the ground that they did not provide for sufficient free space by not showing sufficient ventilation for back windows. The builder pleaded that his plans conformed to the 1866 Act and fell under its exceptions, stating that the proposed apartments were all above the street level. This view the court upheld, and, till the Act be amended, the city cannot insist on what was meant in this respect.

The entire contents of dwelling-houses required now are, exclusive of lobbies, closets, presses, and recesses, 1,000 cubic feet for one apartment, 1,600 for two apartments, and 2,400 for three apartments. Formerly they were 900, 1,500, and 2,000 cubic feet, respectively. The Edinburgh contents are 700, 1,200, and 1,800 feet. The sanitary authorities asked for greater contents in 1879, but did not get them, and those under the 1892 Act form a modification of their demands. The section is to apply to new buildings, or where existing buildings are altered; but provision is made for the restoration of buildings destroyed by fire on their present formation, unless the building be taken down as low as the ground floor.

Ceilings for sleeping apartments are to be 9½ feet high on ground floor, and 9 feet in others, except attics, which may be 8 feet, if the 8-feet height extends to one-half of the area of the room. There is to be only one habitable storey in any roof. This, you will observe, is a modification of what was asked in 1879—namely, 10 feet. It was then admitted that whatever the apartments were, 9 or 10 feet was not so important as making the 10-feet height the vertical scale to measure the free space of the tenements. The Act has provision for this measurement, and so we have now the happy medium between what was claimed by the city authorities and by the objectors.

The Act next provides that not more than 16 separate dwelling-houses shall enter from one common stair in the tenement, or more than 24 from a common stair outside the tenement, or more than 4 houses on each landing or stairhead. Each tenement is to

have its gables carried up through the roof. This provision is so obvious that further remark on it is unnecessary.

Section 38 practically does away with enclosed beds. No recess for beds is to be made unless it is open in front three-fourths of its length. This is so far an improvement. It has long been admitted that a bed in a recess, which has a door on it, and which door may be shut when the bed is occupied, is not by any means a healthy bed, although, I presume, thousands have occupied such beds for years without sustaining any apparent harm.

All roofs are to be constructed of, or covered with, incombustible material, except as regards doors, windows, frames, or lights, and snow boards. This provision is to apply to all buildings after seven years from the commencement of the Act (1st October, 1892). The hand of the firemaster can here be seen to be at work, and as the roofs are generally already in this condition, the provision is not a hard one, and is in the right direction to prevent the spread of fire, which is a powerful destructive agent when it is once allowed any scope.

Section 41 empowers the Dean of Guild to relax the provisions of the Act, and also of the 1866 Act, and of any by-laws, in the following cases, where the Medical Officer or Master of Works reports that there is adequate provision for air and ventilation:—

Blocks of labourers' houses containing more than 24 separate dwellings;

Large inns and hotels;

Houses occupied by caretakers in business premises; and

Asylums, fire-proof buildings, and any other building of a special description.

This is a reasonable provision, but it might be more reasonable and yet quite as safe to have enacted that it shall apply, on the Dean of Guild being satisfied, without providing for a report by the Medical Officer or Master of Works. In this latter case parties would have required to satisfy the Dean of Guild, and not the city officials.

The next four sections refer to forced ground, and walls and foundations of buildings. Instead of providing that, in all cases where the buildings are to be erected on forced earth, the whole site shall be laid with concrete or other material, as was proposed in 1879, the Act says this is to be done where necessary—that is to say, where the ground is not hard and dry. It is, of course, quite possible to have buildings on forced earth, in which nothing

offensive has been placed, and which, after a proper interval, will make a good enough foundation; formerly, however, only the foundations had to be laid with concrete, and not the whole site. If offensive matter has been placed or deposited on the site, it is to be removed or rendered innocuous where new buildings are proposed. The walls on which is supported any roof or floor, and those dividing separate houses, and all staircases, stairs, and landings of new buildings, are to be incombustible. A temporary building or movable structure may be of wood, provided that it is detached by a distance equal to its height, and that its roof is properly covered. The foundations are to project to the extent of one-half of the thickness of the walls, except where they come in contact with existing buildings or rest upon solid rock; and all walls to support floors or roofs are to rest upon proper foundations or sufficient beams, which are to be of incombustible material. These provisions, as I need not explain, are intended to make buildings as much fireproof as is practicable.

The nuisance of smoke from chimney stalks or flues is dealt with by providing that they shall be as high as the chimney tops of any buildings within 100 feet thereof.

A certificate on the drains of new buildings has to be lodged with the Master of Works by the Sanitary Inspector before occupancy, that they have been found satisfactory; and the Master of Works, in reporting to the Dean of Guild upon the completion of the buildings, has to incorporate this certificate. The Master of Works has the charge of connecting private drains with the common sewer, and is to give the owner two days' notice of his intention to do so. The Act next deals with ashpits, repairs of drains, taking over by city of sewers, cesspools, water-closets, cisterns, and soil and waste pipes, but as these are matters of detail, and are of no general interest, I will pass them over.

The next subject referred to by the Act is the question of public buildings, warehouses, and workrooms, and their stairs, accesses, and exits. This, of course, is important, although no amount of provision for proper exits at public buildings will keep down or prevent accidents after panic begins. It is proper, however, to make provision for having public buildings as safe as possible, and I will just mention what the Act provides for in this respect. All dwelling-houses above theatres or buildings where there are hazardous goods must have a fireproof floor, and walls, stairs, staircases, and passages. All such existing buildings

must come under this provision five years after the passing of the Act. In warehouses of more than two storeys, not more than ten persons are to be employed in workrooms which are above the first floor, unless provided with separate stairs, or unless the stairs are near an existing door on the ground floor, or other satisfactory outlet. This provision is also to be enforced as to existing buildings five years from the passing of the Act. The penalty for this is £1 for every day, if the Act is not complied with.

Where more than forty persons are employed on an upper storey of a building having a stair not enclosed by fireproof walls, and not communicating with the street direct, two stairs 25 feet apart, and having separate doors leading direct to the street, are to be provided; and a separate stair is to be provided in cases where a fire might cut off connection of one-fourth of the area of a storey of any building so constructed. Exception is made for factories under the Factory Act of 1878.

A new provision for the inspection of public buildings is made by Section 62, giving the Dean of Guild, on application of the Master of Works, power to direct, after hearing interested parties, what he sees fit to be done in the way of ventilation and drainage, and access and exit, and protection from fire and other dangers. All new theatres, &c., for accommodating more than 1,000 people are to be 15 feet distant on three sides from the nearest building, and the ground floor is not to be more than 3 feet above the street level. This makes it impossible for any one in future to own or lease a new theatre in the centre of tenements and other buildings, and above the street floor.

On the question of appeals from the Dean of Guild Court to the Court of Session, Section 70 makes an important alteration. It provides that a review by the Court of Session of Dean of Guild decisions shall not be excluded by reason of their being on matters of fact, or in the exercise of discretionary or administrative power given him by the Act, or without a written record having been made up. No further back than 1891, the Court of Session held an appeal from the Dean of Guild incompetent, because no record had been made up. (See Walker *v.* Lang, 1891, 18 R. 928.) It also held, however, that the Dean of Guild could not have refused a motion to have a record made up. I presume I need hardly explain this. It just means that, instead of the case being heard *viva voce*, the parties stated their pleadings in writing. Where an appeal is made, the Dean of Guild has to state a case for the

Court of Session, specifying how far his decision rests on matters of fact, and how far on law. This, seeing that the Dean of Guild's powers have been extended, is a fair enactment.

The last section of the Act to which I shall refer is one which provides for the making of by-laws on matters of detail by the Police Commissioners, and it brings us to the by-laws of the Act, to which I need refer only very superficially. They number seventy-four, and many of them, though not formally expressed, have been recognised. It is better, however, to have them definitely put before us, to secure the better compliance in plans and building arrangements. They apply only to new buildings and alterations, except where otherwise provided.

By-law 4 states that no street is to be of less width than the maximum height of its buildings. It is not said that the width is to equal the combined height of the buildings, but that opposite or in front of a 60-feet building the street is to be 60 feet wide. Lanes are not to be less than 15 feet wide, and 20 feet at the closed end. Then, unless the site of the buildings be gravel, sand, or other solid bed, and dry, it is to be laid with 6 inches of concrete, and all offensive matter is to be removed. Any necessary filling-up is to be done by hard brick, or dry stone, sandstone shivers, or other innocuous materials.

Among other by-laws as to walls and cross-walls, &c., it is necessary that all iron beams supporting the main walls are to be surrounded with cement, &c., $\frac{3}{4}$-inch thick. All openings in cross or party walls are not to be higher than 6 feet or wider than 8 feet, and are to have iron doors with iron frames, no woodwork being nearer than 6 inches. This is for fire prevention, as is also the by-law that all gable walls of separate tenements or dwelling-houses are to be 12 inches higher than the roof, and where there are roofs of unequal height, 6 inches higher than the higher roof. The thickness is to be 9 inches, and in buildings not used as dwelling-houses the wall is to be 2 feet higher than the roof.

By-law 24 does away with wood lintels where the span exceeds 5 feet. Staircases not having light from an external wall are to have wall holes of fixed areas—2 storeys, 18 square feet; 3 storeys, 23 square feet; and 4 storeys, 30 square feet; and they are to be lighted from a cupola or sky-light equal to five times their prescribed area.

Among other regulations as to chimneys, it is prescribed that

no wood or timber joist is to be nearer than 4½ inches to any chimney opening. A new regulation is that hearths are to be laid upon concrete or other incombustible substance of 7 inches in depth. Another new point is that no wooden joist, beam, or safety lintel is to be nearer a fireplace opening than 12 inches. The street floor level of all houses is to be 12 inches above the street level, which aims at avoiding damp.

The cleaning of windows above the ground floor has often been brought before the public notice. Under Section 149 (43 of the 1866 Act), females are prohibited to stand on the window-sills above the ground floor. It is now regulated that in houses all window sashes are sooner or later to be so hinged as to admit of the outside of the window being cleaned from the inside of the apartment. This will necessitate the alteration of window frames, and, no doubt, some method will be devised to accomplish this. Indeed, I understand one has already been patented.

All buildings closed in terms of the Glasgow Police Act, 1890, are to have their doors and windows properly secured to the satisfaction of the Sanitary Inspector. (See Section 32 of the 1890 Act.) Among other regulations as to drains, is one that drain pipes are to be laid on solid hard ground or on concrete 6 inches thick. The last by-law to which I shall refer is the one as to width of exits from public buildings. The exits are not to be less than one foot wide for every 70 persons seated in building, and so in each floor or section, and the minimum width of any exit is to be 4 feet. In the auditorium of theatres and music halls there is to be at least one passage 4 feet wide, and the side passages are to be 2½ feet wide. In view of the great risk of danger or alarm arising, it cannot be too well emphasised that there ought to be ample exit accommodation to permit of audiences quickly dispersing when necessary, and to prevent as far as possible the fearful results of the audiences being crushed together so that exit is impossible. This matter has already been very well looked after by the authorities when granting theatre licenses, but it is quite right to make provision under the Act for proper exits and passages.

These, then, are the more important and interesting provisions of the 1892 Act and its by-laws. I have refrained from any attempt at expounding them, for the well-known reason that any Act of Parliament which has not required the assistance of our courts in defining it, on account of ambiguity or other difficulty, is the exception and not the rule.

XII.—*The Apprentice Question.* By JOHN INGLIS, President of the Institution of Engineers and Shipbuilders in Scotland.

[Read before the Economic Science Section, 27th March, 1894.]

HAVING been invited to communicate to this Society an account of the recent agreement between employers and employed with regard to the engagement of apprentices in the iron shipbuilding and boilermaking industries I have put together a brief notice of the events and negotiations which ended in the settlement, for a time at least, of a question which has for years disturbed the peace.

It is as well to make it clear at the beginning that I am of opinion that combinations, as we know them, of workmen or masters, for the purpose of imposing restrictions on numbers of men employed, or on hours of labour, of enforcing alterations in wages, or otherwise hampering or restraining industries, are fundamentally unsound, wasteful in their action, and injurious to the public interest. I do not say, however, that an arrangement whereby representatives of both sides might deliberate on the adjustment of their joint affairs is inconceivable, and might not even be beneficial, inasmuch as, by some such means, one side or other might be prevented from pushing too far a temporary advantage of position, whereas, under the unchecked operation of the law of supply and demand (which some call divine, and others bestial), oppression and hardship are often possible.

But we are still far from ideal relations between master and man, and those who undertake the direction of industrial concerns have to deal with existing conditions; to consider not only what is desirable, but what is attainable in the way of agreements with workmen who decline to be treated as units, preferring to act in masses—at all events so acting—whether from choice or under compulsion.

The workmen engaged in the various operations involved in steamship building are, with few exceptions, combined in societies

governed by rules not sanctioned, so far as I know, by any legally constituted authority. Within those societies individual action is limited and controlled to a degree almost incredible, and breach of discipline visited with penalties imposed by a court from which there seems to be no appeal. Expulsion is insupportable unless the person who suffers it can find employment where the authority of the society is disregarded, and it is obvious that to find such an asylum is not always possible.

Given, then, a group of such societies on the one hand, it is not difficult to see that the correlative must be, on the other, a group of employers combined with more or less compactness. No Employers' Association can ever have the means of enforcing its resolutions upon recalcitrant members which are at the disposal of a Trades-union Executive, and there will probably always be, outside of its pale, a fringe of isolated employers who are content to accept, without acknowledgment, the protection which it affords; still, at the expense of occasional inconvenience and loss, it can, with a fair measure of success, resist the tendency of men endowed with extensive powers to use them without due respect to conflicting interests. Without such resistance, trades-union executives would be more than human if they did not, in time, become extravagant in their pretensions; and, in saying so, I am ready to concede that a council of employers, armed with full powers over their fellow-employers, would stand quite as much in need of a wholesome check.

The petty strikes, which were the result of combined workmen fronting uncombined employers, are now less frequent in shipbuilding yards—an attack on a single employer being resented by the associated firms; and a single employer is not likely to encroach upon workmen without being assured of support. Negotiation has largely taken the place of warfare, although, in this respect, the condition of things still leaves much to be desired.

Among the measures devised for the purpose of raising wages, the restriction of apprentices has, in some industries, long held an important place. The natural disposition towards Free Trade when buying, and Protection when selling, has been indulged in to an inordinate extent in some quarters; and, in the matter of apprentices, the pressure of the Iron Shipbuilders' Society upon the freedom of employers, and on the right of the rising generation to earn a living, became recently so severe that the state of affairs was felt to be intolerable, and hostilities appeared imminent.

It seems hardly reasonable that the burden of resisting such action by a trades society should fall upon employers entirely, but experience has shown the hopelessness of attempts to get our "national palaver" to take up questions of this sort as matters of public policy. Would-be apprentices have no voice collectively, and no votes. Unless they find a stubborn champion, as factory women and children did formerly, their claims are not likely to be regarded at Westminster. Besides, the qualification of the House of Commons to deal intelligently with industrial legislation is at least open to discussion, if we consider the composition of it. With the assistance of "Hazell's Annual Cyclopædia," I have prepared a kind of *spectrum* of that august body which may give us some idea of the extent to which it is likely to possess a practical knowledge of the conditions under which the industries of the country are carried on.

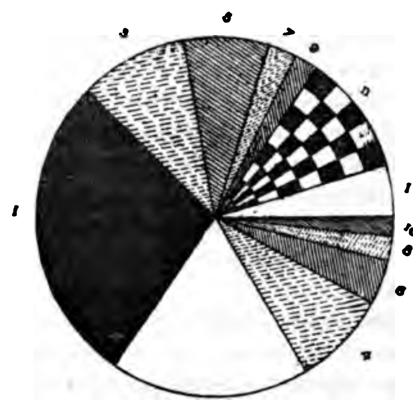


FIG. 1.

This circle (Fig. 1) represents the present House on a scale of one legislator to a square inch; it is, therefore, 670 square inches in area.* The black sector represents the noble army of barristers and solicitors, who compose over 27 per cent. of the "faithful Commons." The yearning of members of the legal profession to serve their country in Parliament is extraordinary, and the result of it is that, out of a body comprising only 6 per 1,000 of the male population over twenty years of age, we submit to be persuaded to return such a number that lawyers are forty-five

* Fig. 1 is, of course, reduced from the original diagram.

times as numerous proportionally within the House as without it. Sector No. 2 denotes the landed gentry and others who appear to be relieved of the necessity for toiling or spinning for a livelihood. These form 18 per cent. of the House. The third sector represents the 10 per cent. composed of merchants, bankers, stockbrokers, and accountants. No. 4 represents the scientific men, the physicians and chemists, architects, literary men, and journalists—together about 8½ per cent. The military and naval heroes—active or extinct volcanoes—are represented by the fifth sector. They constitute about 7½ per cent. of the House. The sixth division shows what seem to be politicians by vocation—4 per cent.; and the seventh the coal and iron masters—a small body, only about 2¾ per cent. The eighth sector represents the brewers and distillers not yet ennobled—2½ per cent.; while the ninth exhibits the proportion of martyrs who have been delivered from Irish prisons, to which they had been consigned, most probably, by their present political allies. The tenth displays the members for labour—insignificant in numbers, but noisy in debate; and the chequered sector, No. 11, represents 11 per cent., embracing shipowners, shipbuilders, engineers, founders, contractors, and manufacturers of various fabrics—employers of labour having experience of the management of ships, factories, and workshops, of dealing with bodies of workmen, and of the risks and difficulties of various occupations. The circle is completed by the twelfth sector—5 per cent. in area—left white to signify the impossibility of discovering what this remainder, consisting chiefly of Irish rhetoricians, had been brought up to.

A majority of this House professes to see no incongruity in legislation which forbids the workmen to contract, of his free will, with his employer for pecuniary aid in case of disablement by accident, and, at the same time, permits him to be compelled, against his will, to contract with a trades union for the arrangement of the terms of his employment, thus completing the severance of any connection between master and man as human beings, and rendering all but impossible that mutual regard which philanthropists would prefer to see developed and sustained.

This is a long digression, but I am anxious to justify the shipbuilders in electing to attempt the regulation of the apprenticeships in their establishments without making that appeal to the Legislature which, under other conditions, might have been the best and most direct way of dealing with the question.

After many collisions between the Iron Shipbuilders' Society and employers, particularly on the Clyde and at Belfast, it was suggested to the leaders of the society that, instead of fighting over a question which no one appeared to completely understand, it might be wise to consult some authority, or instruct an expert to investigate it with the view of ascertaining if possible what relation existed between the supply of apprentices and the demand for skilled workmen. It was thought desirable that this authority or investigator should be outside of the dispute, and the name of Mr. Giffen, of the Board of Trade, was suggested as that of a man eminently qualified to undertake the enquiry. After some discussion, Mr. Giffen's fitness was admitted by both sides, and he was approached on the subject; but, though willing to act as an umpire whose award should be final and binding on both parties, Mr. Giffen declined to be simply an adviser whose advice might or might not be followed, and the advantage of his services was, therefore, not secured. No one else appearing willing to search for a solution of the question, I resolved, not without misgivings, to make an attempt, and, after several failures, hit upon the method now to be described.

It is the merest commonplace to say that, although every man must have formerly been a boy, and before that an infant, not every male infant, or every boy, becomes a man; but it will doubtless surprise many to be told for the first time that, at a given instant, about one-fourth of the population of this country is under 10 years of age, 65 per cent. are under 30, and 85 per cent. under 50 years of age. The average age of all persons living is about 26 years, and the average age at death is a little over 47 years. From inspection of many tables of the distribution of population according to age, it can be ascertained (1) that such distribution is very stable over long periods, and (2) that it is very similar in different countries. So permanent and so universal does it seem, that I can see no risk in founding upon it, and predicting the future from observations of the past, with almost the precision with which our astronomers prepare the Nautical Almanac.

Fig. 2 shows graphically the age-distribution of the population of Great Britain, the scale of numbers being along the base, and that of ages on the ordinates set up from the base. Of course, while the curve is practically permanent, the individuals from whom its ordinates are derived are perpetually changing.

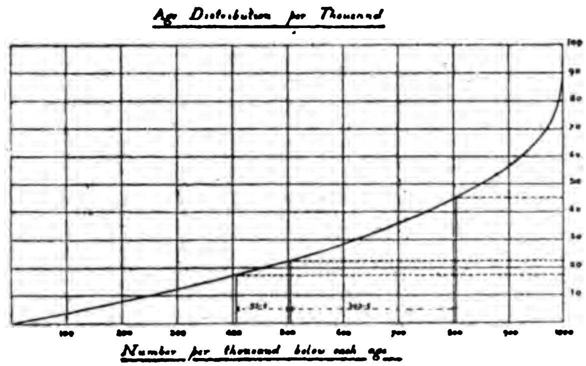


Fig. 2.

New births are keeping up the supply at one end, while, at all points of its length, losses are occurring by death, so that, out of all the children under ten years of age, only about one in ten survives till over 70.

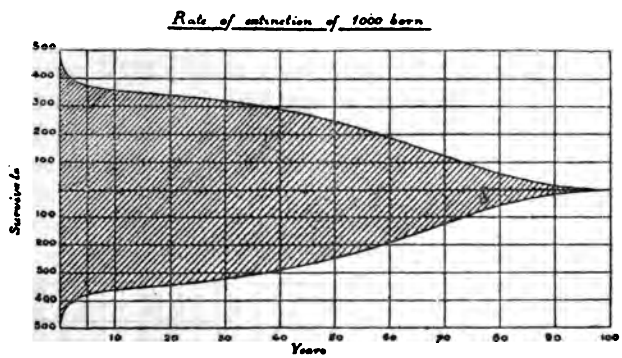


Fig. 3.

In Fig. 3 is shown the rate at which the population of this country dies out. On the left the total births are set off to scale, and the breadth of the figure at any cross section shows the number of survivals at the corresponding age.

When we are once in possession of the second of these diagrams, it seems to admit of no dispute that we can immediately derive from it the number of persons between two given ages who will survive out of a number of younger persons between other two age-limits; or, conversely, if a certain number between two given age-limits be required, how many younger persons between other two age-limits must be set apart, so that the natural wastage

may be provided for. Applying this process to the case of the iron shipbuilders, we have first to determine at what age a man ceases to labour in his vocation.

The reports of the men's union show that the average age at death is 45 years. The number which continues at work after that age is so trifling, and we have to set off against these the greater number which does not so continue till death supervenes, that we may take it that there are, for practical purposes, no men available after 45. Twenty-two, as the age at which a journeyman's life begins, is certainly on the early side, but steps are being taken to make that the standard age for completion of apprenticeships, and the duration of a journeyman's working life may, therefore, be set down at 23 years at most. This figure has been adopted by Mr. Robert Knight, Secretary to the Iron Shipbuilders' Trades Union, and, as he has exceptional opportunities of knowing, it may be held as established.

An apprentice completing his time at 22 begins at 17, and these age-limits may be taken as the standard for apprentices.

By inspection it is found that in every 1,000 of the population there are between 22 and 45 years of age, 302·5 persons, and between 17 and 22 years of age, 93·5 persons. This fixes the ratio between apprentices and journeymen, which will keep the numbers of the latter constant, at 100 apprentices for every 323 journeymen.

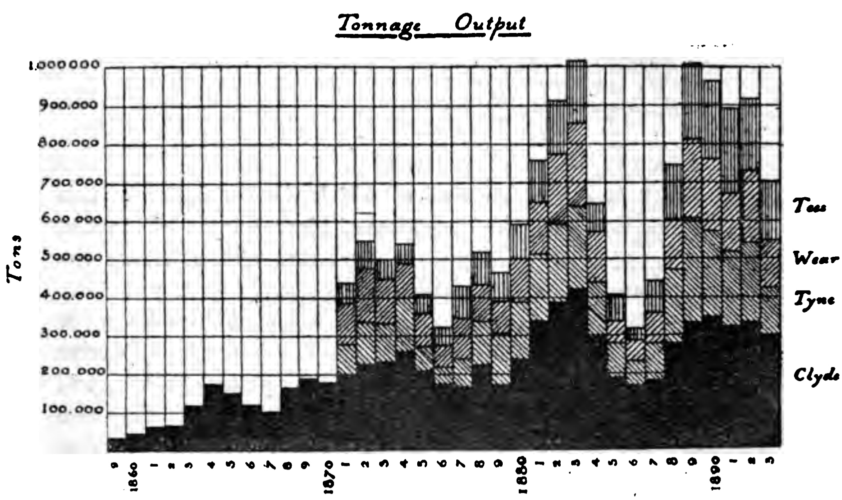


FIG. 4.

Whether or not it is desirable to keep the number of journeymen constant is another question. In this connection, Diagram No. 4 shows the output of tonnage on the Clyde for 35 years, and also on the Tyne, Wear, and Tees for 23 years.

It is very evident that any settlement which would have kept the number constant at that which was sufficient twenty-five years ago would have effectually prevented the expansion of steam shipping to the present dimensions, and would have had a commanding influence on the price of every commodity in daily use. It is not within the scope of this paper to determine or inquire whether this would have been a national benefit or not, but there can be no reasonable doubt of the fact.

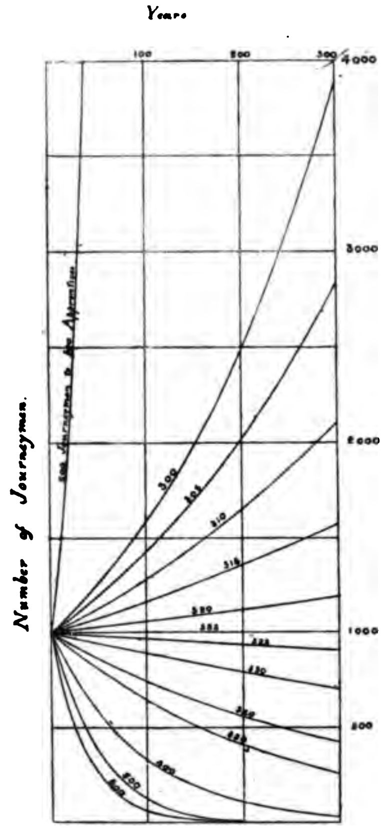
I had the honour of submitting my answer to the Apprentice Question to the Labour Commission, and since then it has been frequently before the public in newspapers and technical journals. No doubt has been cast on the soundness of the theory except by Mr. Knight and some of his colleagues, and a rival theory was propounded before the Commission, which may be found in the Minutes of Evidence, Group A, Answer No. 20,683. I must confess myself unable to follow the reasoning of Mr. Knight, but I am quite certain he starts from imperfect data.

These theories were being discussed in a desultory sort of way, but settlement was still delayed, and the Iron Shipbuilders' Society, becoming very impatient, brought things to a head by proclaiming that, after a certain date, all apprentices would be compelled to procure a form of permit, granted by their society at its discretion, and regularly *visé* by its branch officers; but the result of a meeting with a committee of employers was the withdrawal of this notice, and, after frequent conferences and protracted discussions, the regulations given in an appendix were formally adopted.

In these the ratio between apprentices and journeymen is fixed in shipyards at 100 to 350, the average number of men employed during 5 years to be taken as basis. As no restriction on numbers is imposed in boiler-shops, it is probable that the whole number of apprentices will have very nearly the ratio to journeymen that my investigation shows will keep the number of workmen constant. And so, in the meantime, there is peace between us on that question, which has been a fruitful source of trouble for many years.

I admit that it is entirely wrong to fix the number of apprentices on the basis of the number of men actually employed at any

given time. The proper basis is the number of men which will be required in the future; and as no one can pretend to give us reliable information on that point, there ought to be no artificial restriction whatever, but the matter should be left to settle itself, as it has done from the earliest days of iron shipbuilding until the interference of trades unions began.



Rate of increase or decrease in number of Journeymen according to ratio of Journeymen to Apprentices.

FIG. 5.

Diagram No. 5 shows the results of choosing and adhering to various ratios above, at, and below that which maintains the number of men constant. No demonstration is required to prove that, if the number of men is in excess, the number of

apprentices should be reduced, and *vice versa;* also that the system of a fixed ratio between boys and men is likely to aggravate any want of correspondence that may at any time exist between the number of men to be required and the number of boys being prepared to fill the vacancies.

But the constant irritation which prevailed so long as the question remained unsettled was more injurious to our industry than the arrangement we have made, which I admit to be imperfect. Those upon whom the burden was laid of making it felt that, between what the trades society was willing to concede, and the perfect freedom which is the only rational settlement, the difference practically was not great enough to be worth a prolonged contest, and I am not without hope that the result of the experiment will be to convince both sides that it will be more advantageous to seek for a new and better solution in a peaceful manner than to revert to the tug-of-war methods too frequently employed for the settlement of working conditions. It is much to the credit of the Iron Shipbuilders' Society, the Executive, and particularly the Secretary, Mr. Knight, that they were ready to lay aside the old weapons and discuss the points of difference with calmness and forbearance. That they should all at once admit our arguments to be irresistible and our deductions sound is hardly to be looked for: it is enough for the present that they credit a body of employers with some regard for other interests than their own.

It may be urged that a federation of employers should not have been content with a settlement falling short of perfection, and an important body of employers acting with us, though not of our membership, dissented because we had not resisted to the uttermost the imposition of any restriction whatever. But it must be borne in mind that we have our business proper to attend to, and cannot devote all our energies to striving for the greatest good of the greatest number present and to come. Whoever may raise objections, none can come with a good grace from these employers who stand behind, and whose appetite for chestnuts is qualified by their dread of fire and solicitude for their own fingers.

[APPENDIX.

APPENDIX TO MR. INGLIS'S PAPER.

MEMORANDUM OF ARRANGEMENT *re* THE APPRENTICE QUESTION, BETWEEN THE EMPLOYERS AND THE COMMITTEE OF THE BOILER-MAKERS AND IRON SHIPBUILDERS' SOCIETY.

TO APPLY TO SHIPYARDS ONLY.

1.—Boys about 14 years of age to be taken on as "Platers' markers," "Rivet boys," and similar work, as Probationers. These boys are not to be bound in any way.

Except in special cases, the Apprentices will be selected from the most capable and best conducted of these probationers.

2.—Apprentices who have not been probationers to commence at the age of 16 years, and to serve 5 years. Probationers to commence their apprenticeship at 16 years of age, if possible; but in cases where there are not vacancies for them as Apprentices they can be allowed to commence at any time not later than 18 years of age. The limitation of 18 years not to apply to boys actually on the books at present. In all cases 5 years' apprenticeship must be served.

3.—Every Apprentice is to come under an indenture or written agreement, as may be adopted by the Firm of Employers where the apprenticeship is served. The indenture or agreement to be subject to revocation in the event of misconduct on the part of the Apprentice.

During the term of apprenticeship, in shipbuilding yards, the Apprentice is to work, as required, in or out of his Employer's works, at new or old work, and on time or piece, at the discretion of his Employer, and as regards boiler-works, existing arrangements to continue. He is not to belong to any Trade Society (except for the purposes of benefit), nor is he to be interfered with in any way by any Trade Society.

A certificate of having served his apprenticeship is to be granted to the Apprentice at the expiration of his agreement.

4.—Apprentices are not to leave their employers except with their permission in writing.

5.—All time lost during the year, unless accounted for by certificates of Sickness, must be made up at the end of each year. The minimum rates of pay for Apprentices shall be as follow:—

1st year,	6s. per week.
2nd ,,	7s. ,,
3rd ,,	8s. ,,
4th ,,	9s. ,,
5th ,,	10s. ,,

Piece-work rates to be arranged locally—*i.e.*, by districts.

6.—Restriction in the number of Apprentices, which has been admitted in shipyards, is not to apply to boiler-shops and bridge-yards.

7.—In shipyards the ratio of Apprentices to Journeymen to be two Apprentices to seven Journeymen.

8.—The number of Journeymen for the purposes of Clause 7 is to be determined by the average number employed during five years. Apprentices are not to be discharged owing to a temporary falling-off in the number of Journeymen.

9.—Any firm starting new yards or materially extending their business, and thus employing a larger number of Journeymen, to be specially considered as regards the number of Apprentices.

10.—All men employed in the different shipbuilding departments, whether working inside or out, who are eligible as Members of the Boilermakers and Iron and Steel Shipbuilders' Society, are to be reckoned in estimating the number of Apprentices.

11.—The above Rules are not to apply to Premium Apprentices.

12.—This Agreement to be in force for six years.

Note.—The Employers recognise that the sons of men working in the different departments of the Shipbuilding trade have a claim to be taken on as Probationers, and while not binding themselves to do so, they will endeavour to give these lads the preference.

(Signed) H. DYER,
Chairman, Employers' Committee.

(,,) R. KNIGHT,
General Secretary, Boilermakers and Iron and Steel Shipbuilders' Society.

NEWCASTLE, 11*th October*, 1893.

The following clause, discussed and agreed to at the Meeting between the Employers and the Deputation of the Boilermakers and Iron Shipbuilders' Society at Newcastle, but omitted in the Memorandum of Arrangement, is now added to the foregoing Arrangement, to meet the views of some of the Employers, viz.:—

"Apprentices may be suspended during times of depression, and when the exigencies of trade require it; but the Apprentices so suspended are not to be employed by any other Employer during such period of suspension except by mutual agreement between the local Employers' Association and the Boilermakers and Iron Shipbuilders' Society."

(Signed) H. DYER,
Chairman, Employers' Committee.

(,,) R. KNIGHT,
General Secretary, Boilermakers and Iron and Steel Shipbuilders' Society.

NEWCASTLE, 13*th January*, 1894.

XIII.—*On the First Edition of the Chemical Writings of Democritus and Synesius.* Part IV. By Professor JOHN FERGUSON, LL.D., F.S.A., F.C.S., President of the Society.

[Read before the Society, December 13th, 1893.]

1. Two sessions ago, on November 18th, 1891,[1] I submitted to the Society complete proof that the edition of the works of Democritus and others by Pizimenti, apparently published at Padua in 1573, was originally dated 1572, and that the date had been subsequently altered by the insertion of an additional figure I. Photo-facsimiles of the title-pages of three 1573 copies were sufficient of themselves to have established this fact; but there was, over and above, the direct evidence of the copy actually dated 1572, in the Bibliothèque Ste. Geneviève—after which there was nothing more to say.

2. It was not settled, however, whether or not there was a previous edition. Later on, I was startled and interested by being told "that in the Bibliothèque Mazarine at Paris there is a copy of an edition of Democritus *De Arte Magna*, by Pizimenti, printed at Padua in 1570, in 4°," and to the paper I added a supplementary note with that information, on October 1st, 1892.[2] This, as I then observed, was quite an unlooked-for enlargement of the list of editions, for, though one printed at Rome in 1570 had been mentioned by Conring, there was no allusion anywhere to one printed at Padua in that year. There was no alternative, however, but to accept the statement as I received it, and to express the hope, as I then did, of laying before the Society the results of my inquiries about this hitherto unknown edition, which I am now able to do.

3. In February last I obtained a photograph of the title-page and a description of the copy in the Mazarine Library. The photograph, which I have had printed like the others, tells its own story, the *dénouement* of which could not well be more

[1] *Proceedings* of the Philosophical Society of Glasgow, 1892, Vol. XXIII., p. 153.

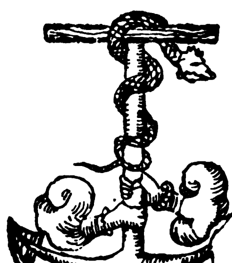
[2] *Ibid.*, p. 167.

DEMOCRITVS ABDERITA DE ARTE MAGNA.

Siue de rebus naturalibus.

Nec non Synesii, & Pelagii, & Stepha-
ni Alexandrini, & Michaelis Psel-
li in eundem commentaria.

Dominico Pizimentio Vibonensi
Interprete.



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tantalising, for just the most important part of all, the date, is missing. Comparison, however, with the other title-pages leaves no doubt that this is nothing but another copy of the 1572-73 edition, which is confirmed by a collation of the book itself. From the description accompanying the photograph[1] the following extracts give all necessary information. In his letter M. J. Havet styles it correctly "the so-called Democritus of 1570 in the Bibliothèque Mazarine, vol. 27,481. As may be seen," he adds, "the lower part of the leaf is torn out, leaving the year uncertain; the sole authority for supposing this to be 1570 is the entry in the manuscript catalogue of the Mazarine, compiled in the XVIII[th] century. But if your friend will take the trouble to compare this photo with the edition of 1573 (of which we have a copy in the National Library, R. 33395), he will easily convince himself that it is the same book. The number of pages, paging, signatures, &c., are the same. From this we can, I think, safely infer that the entry in the Mazarine Catalogue is erroneous, and that the edition of Padua 1570 never existed."

I myself have not the smallest doubt that the date in the Mazarine Catalogue is an error, and that this is a copy of the 1572-73 edition. It so happens that I have already given[2] a facsimile of the copy referred to (Bibl. Nat., R. 33395), and comparison will show identity, even to the correction of the initial I to A in ABDERITA, and to the defect in the lower part of the initial P in PATAVII. From the arrangement of the figures it is quite obvious that the date could not have been MDLXX., if they were placed symmetrically below PATAVII, and in the centre of the title. Whether, however, this was an original unaltered copy, like that in the Ste. Geneviève Library, or an amended one, like all the rest, it is impossible to decide; the crucial test, unfortunately, cannot be applied.

I think we may infer that this was an imperfect copy when it was catalogued. If it had been unmutilated, then the date in the catalogue would have been either 1572 or 1573; but, as this guidance was wanting, the cataloguer had to fall back on internal evidence, and, finding Pizimenti's dedication dated 1570, he assumed that to be the date of the printed volume. One is

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[1] For both I am indebted to Mr. J. Y. W. Macalister, F.S.A., who procured them from the late M. J. Havet, of Paris.

[2] In Part III., § 5, *Proceedings*, Vol. XXIII., p. 154.

hardly justified in saying, from the exact similarity of this and the Bibliothèque Nationale copy, that a Padua edition of 1570 never existed, but the existence of any edition dated 1570 is certainly rendered less and less probable, when every fresh copy that is examined proves to be dated 1572, or usually 1573. Anyhow, no 1570 copy is as yet forthcoming.

4. The Mazarine copy is not the only one to be added to the list; there is another, dated 1573, in the Library of St. Mark at Venice. For an account of this copy, with a tracing of the title-page, I am indebted to Sign. Mario Girardi, Librarian of the Royal University of Padua, who wrote me a letter on the subject a year ago, on December 26th, 1892. Though a tracing cannot be quite so exact as a photograph, I have had it reproduced, for it is sufficient to illustrate the alteration of the initial of ABDERITA, the alteration of the date by the insertion of the numeral I, and the identity of the title-page in all respects with the others.

This copy is the fourth in a volume of pamphlets, and is numbered 44659. Comparison of it with the account given by me in Part III., § 14 (a copy of which had been sent to Sign. Girardi), showed that the book is exactly similar to the Cambridge copy, and, therefore, also to the copy described below in § 11.

5. With regard to the title-page, Sign. Girardi draws attention to the fact that the initial A in ABDERITA occupies a position similar to that in the Bibliothèque Nationale copy, which, as will be seen from the facsimiles, is different from that in the Cambridge and Göttingen copies. In the latter two the corrected A covers the original I, and falls nearly under the E in DEMOCRITUS, whereas in the Paris and Venice copies the A comes close to the B, and is placed nearly under the M of DEMOCRITUS. The Venice copy has also a spot of ink where the I has been, and the letter can be traced through it, so that in this copy the I has been attempted to be cancelled, and the A has been put in separately, whereas in the Cambridge and Göttingen copies the I has been obscured by having the A put on the top of it. As to the position of the middle figure I in the date, it resembles the Göttingen copy, and not those of Cambridge and the Bibliothèque Nationale.

6. As not infrequently happens that the place where a book was printed retains no example of it, so it is here. Padua possesses no copy of this book that first appeared in it. There is, however, another copy, dated 1573, in the Biblioteca Comunale of Verona. Of the title-page of this copy I am able to give a facsimile from a

DEMOCRITVS ABDERITA DE ARTE MAGNA.

Siue de rebus naturalibus.

Nec non Synesii, & Pelagii, & Stephani Alexandrini, & Michaelis Pselli in eundem commentaria.

Dominico Pizimentio Vibonense Interprete.

PATAVII
Apud Simonem Galignanum
M D LXXIII.

DEMOCRITVS ABDERITA DE ARTE MAGNA,

Siue de rebus naturalibus.

Nec non Synesii, & Pelagii, & Stephani Alexandrini, & Michaelis Pselli in eandem commentaria.

Dominico Pizimentio Vibonensi Interprete.

PATAVII
Apud Simonem Galignanum
M D LXXIII.

photograph by R. Lotze, of Verona. The points to be observed are, as usual, the initial A of ABDERITA, and its position under the E of DEMOCRITUS, and the position of the inserted I in the date. In this instance it is placed rather to one side, so that this particular example corresponds with the Cambridge University and Bibliothèque Nationale copies.

7. To the evidence already adduced that the edition of 1572-73 is the first of this book, there may be added, if such be needed, the statement of an author whom I was unable to quote in my previous paper (Part III., § 10). Philip Labbe, in his very rare book,[1] *Nova Bibliotheca MSS. Librorum*, Paris, 1653, 4°, p. 128, mentions the fact that the treatise of Psellus on the confection of gold, addressed to Michaël Cerularius, was translated by Pizimenti, and published along with Democritus Abderita, Synesius, Pelagius, and Stephanus Alexandrinus De Magna et Sacra Arte, at Padua, by Simon Galignanus, in 1572, in 8vo. This is an earlier allusion to this edition than any I have hitherto encountered. The rarity of Pizimenti's book must have been great even two hundred and fifty years ago, for it remained unknown to Reinesius when he was describing the Altenburg-Gotha[2] manuscript of the Greek alchemists, though quoted in a note to his tract on the same topic which Fabricius printed afterwards in 1724.[3] It is remarkable that, in this account by Labbe, Psellus' tract is said to be dedicated to Michaël Cerularius, whereas in the printed edition of 1573 it is dedicated to Xiphilinus, the Patriarch. What was the reason for this change does not appear. It is quite certain, however, that in a manuscript of the tract in Greek, preserved in the Vatican, the dedication is to Cerularius.[4]

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[1] There is no copy in the British Museum, but I have got it in the University Library at Cambridge. Sign. Girardi, who refers to this book, says that he has not had access to a copy of it.

[2] *Variae Lectiones*, Altenburg, 1640.

[3] *Bibliotheca Graeca*, XII., p. 750. This note may be by Fabricius.

[4] Henricus Stevenson, *Codices Manuscripti Palatini Graeci Bibliothecae Vaticanae descripti.* Romae Ex Typographeo Vaticano MDCCCLXXXV. 4°, p. 270:—

*415. Chart. in 8, Saec. XV exeuntis. . . .

> MICHAËLIS PSELLI (iunioris, Tractatus) Περὶ χρυσοποιΐας, seu de auri conficiendi ratione, ad Michaëlem (Cerularium), Patriarcham (C Politanum). Inc. Ὁρᾷς, ὁ ἐμὸς δυνάστης, ὅ με ποιεῖς f. 35.

Pizimenti's translation begins (f. 65 *recto*): Vides ò domine quidnam facis meus dynastes, & animi mei tyrannis?

8. To those who have quoted the 1572 and 1574 reprints appended to the Cologne edition of Mizaldus must be added Eloy.[1] Under "Democrite," he refers to the Greek MSS. bearing his name which exist in the Library at the Louvre, but which were supposed to be spurious, and then he quotes from Vander Linden Mizaldus' *Memorabilia*, with Democritus, Synesius, and Pelagius appended, Coloniæ, 1574, and a Greek MS. at Leyden of the *Physicorum & Mysticorum Liber cum Synesii & Stephani Commentariis.* In a later edition[2] he says of this MS.: "Il étoit à Leyde parmi les Manuscrits de la Bibliothèque de *Jean Elichmann*, savant Médecin de cette Ville." Then he quotes the title of Pizimenti's tract, and adds: "Ou trouve ce Livre dans le Recueil d' *Antoine Mizauld*, qui a paru à Cologne en 1572, *in*-12, & en 1574, *in*-16, sous le titre de *Memorabilium, sive, Arcanorum omnis generis Centuriæ novem.*

9. In Part III., § 12, a certain amount of evidence has been adduced which throws strong doubt upon the existence of a German translation of 1717. If anything more were wanted, it can be got in a book which I knew, but omitted to quote on that occasion. Reference was made to three works by Friedrich Roth-Scholtz, but there ought to have been added a fourth, his *Deutsches Theatrum Chemicum*, Nürnberg, 1728-32. In his preface to the third and last volume, 1732, he gives a list of chemical works which he had published between 1717 and 1732. On p. 23 occurs the following:—

> XIII.—DEMOCRITVS, *Abderyta Græcus*, de Rebus Sacris Naturalibus & Myſticis; cum Notis SYNESII & PELAGII. 8. Norimbergæ, apud Hæredes Joh. Dan. Tauberi. 1717.

Again, on p. 25:—

> XVIII.—Des vortrefflichen Abts SYNESII, aus Griechenland, Chymiſche Schrifften, von dem gebenedeyten Stein der Weisen und deſſen Bereitung; wie ſolche ehemahls aus der Kayſerlichen Bibliothec ſind communiciret, nun aber zum Druck befördert worden, durch Friederich Roth-Scholtzen, Herrenſtad. Sileſ. 8. Nürnberg, bey Joh. Dan. Taubers ſeel. Erben. 1718.

At the end of this volume, in order to fill a few blank leaves, Roth-Scholtz adds a list of old and new chemical books

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[1] M. F. J. Eloy, *Dictionnaire Historique de la Médicine*, Liége & Francfort en Foire, 1755, 2 Tomes, 8vo. I., p. 276.

[2] *Dictionnaire Historique de la Médecine, Ancienne et Moderne.* Mons, 1778, 4 Tomes, 4°. Tome II., p. 20.

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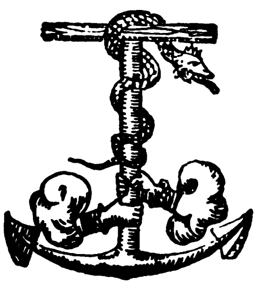
Siue de rebus naturalibus.

Nec non Synesii, & Pelagii, & Stephani Alexandrini, & Michaelis Pselli in eundem commentaria.

Dominico Pizimentio Vibonensi Interprete.



PATAVII
Apud Simonem Galignanum
M D LXXIII.

to be had at a cheap rate from Johann Daniel Tauber's heirs in Nürnberg. Among others is the following, p. 959 :—

> Democritus Abderyta Græcus de Rebus Sacris Naturalibus & Myfticis, cum Notis Synefii & Pelagii, Tumba Semirandis (*sic*) Hermeticæ (*sic*) Sigillatæ quam fi Sapiens aperuerit, non Cyrus, Ambitiofus, Avarus 8. Norimbergæ, 1717.

This last entry is both imperfect and inaccurate, as can be seen by referring to Part I., § 13. That, however, does not concern us, because the chief reason for which I quote these notices is to show the entire absence in them, as in the earlier ones, of reference to a *German* translation of Democritus, Synesius, & Pelagius, dated 1717. The work ascribed to the Abt Synesius is, as I pointed out in Part I., §§ 16, 17, and in the Postscript to that Part, § 3, quite different from the commentary by Synesius on Democritus.

If, therefore, there was such an edition, it was not edited by Roth-Scholtz, and it was not published by Tauber's heirs, and, therefore, my opinion is stronger than ever that there is no edition in German of 1717, and that Dufresnoy and Schmieder, who are the sole authorities for it, are both in error.

10. This part of the subject has now been exhausted. Other copies, dated 1572 or 1573, as may be, are doubtless still to find, but, unless they have manuscript notes, they cannot be expected to add anything to what is now known about the history of the book.

My opinion further is, that an edition of 1570 and the German translation of 1717 must be finally given up. The evidence for their existence is so small and feeble, it rests on such defective authority, and can be so easily overturned, whereas the evidence against their existence is so abundant and strong, becoming more and more conclusive with every new discovery, that nothing except actual copies of both would convince me now that such editions were produced. Such evidence, I think, will never be forthcoming, and, therefore, it may be affirmed, with all certainty, that the first edition of Pizimenti's work is that dated 1572-1573.

11. Had I planned a conclusion to this series of researches, which have now extended from November, 1884, to the present time, I could not have got one more appropriate than that which has spontaneously offered itself to me. On the 28th of November last, just a fortnight ago, a copy of the book, about which so much has been written during the past three hundred years, came

into my possession, and I have brought it to-night for exhibition. All the copies of this edition which I have quoted are in public libraries. This is an unknown copy, and bears no evidence of the source from which it has come. I have had the title-page photographed and printed for comparison with the others. In this, as in the Cambridge and Göttingen copies, the initial A in ABDERITA is larger than the other letters, and it is printed over the original I, though not so as to altogether conceal it, and it falls under the E in DEMOCRITUS. The added I in the date, like that in the Göttingen and Venice copies, is placed about half-way between the other two. It is, as in all the others, a shade smaller in size, and in this particular copy it proclaims itself as an obvious addition, by being less clearly printed than the rest.

12. After all is said, the book is not much to look at, and some wonder may be excited as to why it should have attracted so much notice. The answer is obvious: because it is the first attempt to make known the oldest views promulgated on the *sacred art*, *the great art*, on *alchemy*, as it was termed at a much later date, after the Arabian chemists had taken it up. It is, in short, the first edition of the oldest writing on Chemistry. It is possessed, therefore, of supreme historical importance as the translation of a document that emanated from one who may have lived as early as the second century A.D., and certainly not later than the fourth century.

Even though the Latin text be now easily available in Kopp's reprint, and the Greek text in Berthelot's edition, that in no way diminishes the value of Pizimenti's version as a historical authority. Kopp reprinted Democritus only; Birckmann reprinted Democritus, Synesius, and Pelagius; so that for Stephanus Alexandrinus and Psellus, recourse must still be had to the Padua edition. Moreover, as Pizimenti's version was made from a MS. which came from Corfu, and not from the St. Mark MS., which is the basis of Berthelot's edition, it serves to show how far the two MSS. agreed with one another. Besides, Pizimenti, living at a time when the belief in alchemy and in the possibility of transmutation was a genuine one, viewed the treatises he translated in a very different way from what could be done at the present time by any editor or historian however unbiassed, however anxious to deal fairly with these older conceptions and theories. To Pizimenti alchemy was a vital motive and factor; to the modern student it is a past finished fact.

13. There is also the interest attaching to the book itself, its remarkable rarity, and its history. Certain not unprofitable general considerations can be drawn from even the bibliography of this book. In 1867 Dr. Kopp knew of only one copy of Pizimenti's translation, which he got after much seeking. Books so rare as that are sometimes called unique, and their value is naturally to a certain extent enhanced thereby. In the course of this research ten copies have been mentioned, and there may be, probably there are, more. It is never safe to assert, and it is all but impossible to prove, that of the edition of a book published in the ordinary way the one copy that is *known* is *unique*. Of books believed to be so, and described in important catalogues as such, it has happened that other copies have been discovered which have dispelled that belief.

The course of the inquiry further shows how very hard it is, in the absence of definite data, to determine by mere speculation and inference a matter of fact so apparently simple as the date of a book. The difficulty, perhaps, is not so much in fixing the year as in detecting and nullifying the errors of those who thought they knew it, but did not, and of those who adopted the errors of others without either thinking or criticism. But if such errors have been made as to the date of an obscure book, and the correction and dispelling of them involves so much investigation and examination of minute detail, what certainty can be felt about the accuracy of much that passes current for ancient history, and for all that passes for modern or newspaper history, which is nothing but fanciful narrative from unsifted data—that is to say, no data at all? So one bibliography supersedes another because it is more accurate; one historian pushes others from their stools because he has taken more trouble with the facts, because his errors are less abundant.

14. The most annoying circumstance connected with the whole inquiry is the unpardonable stupidity of Fra. Massimiano da Crema, *Inquisitor Paduæ.* When he admits that he saw the book, partly in print and partly in manuscript, and yet leaves this all-important statement without a date, which would have been invaluable for the history of the book for all time coming, his incapacity for the post he held stands self-revealed. Had he dated his permit, we might have had a clue to the cause of the alteration of the year; to the time when the material for the Cologne reprint was despatched; to the cause of the licence being received after the printing was

begun. We might have known whether the book of 83 leaves, partly in print, which he mentions, was this edition, begun in 1572, or another earlier one. There is nothing for it but to lament the want of this date, and wish that fate could deliver the *Inquisitor* over to us for one brief, but for him very bad, quarter of an hour. May one hope that, for leaving his work in this world undated, the punishment he is deservedly undergoing is, as regards its conclusion, in the same condition?

15. It seems fitting now to give, as on former occasions, a list of all the copies of the different editions, knowledge of which has accumulated during the course of my inquiries:—

1893 List.

1.	Padua, 1572, ...	... Bibliothèque Ste. Geneviève, Paris.
2.	Cologne, 1572, ...	... Hunterian Library, Glasgow.
3.	,, ,, ...	... University Library, Glasgow.
4.	,, ,, ...	... University Library, Cambridge.
5.	,, ,, ...	... New College, Oxford.
6.	,, ,, ...	... Trinity College, Cambridge.
7.	,, ,, ...	... Copy seen by Dr. Kopp.
8.	Padua, 1573, ...	... University Library, Cambridge.
9.	,, ,, ...	... Bibliothèque Nationale.
10.	,, ,, ...	... University Library, Göttingen.
11.	,, ,, ...	... Barberini Library, Rome.
12.	,, ,, ...	... ,, ,, Rome.
13.	,, ,, ...	... Biblioteca Di S. Marco, Venice.
14.	,, ,, ...	... Biblioteca Comunale, Verona.
15.	,, ,, ...	... Professor Ferguson's copy.
16.	,, 1572-73,...	... Bibliothèque Mazarine, Paris.
17.	Cologne, 1573, ...	... British Museum.
18.	,, 1574, ...	... University Library, Cambridge.
19.	,, ,, ...	... University Library, Aberdeen.
20.	Nürnberg, 1717,	... Young Collection, Glasgow.
21.	Braunschweig, 1869,	... Reprint in Kopp's Beiträge.
22.	Paris, 1888, ...	... Berthelot's Greek edition.

16. It is to myself, after all I have had to say and to argue, a most satisfactory result that at the very end I can bring before the Society a copy of this exceedingly rare book—so far as I know, the only one in Scotland, and, with the exception of the Cambridge one, the only one in Britain—and in so doing to express my belief that this part of the subject is at last concluded.

[*Note.*—Brussels, 28th September, 1894.—Since the preceding was printed I have seen once more the copy at the Ste. Geneviève

Library at Paris, and hope to be able to complete the series of facsimiles by giving one of the sole surviving 1572 title-page. This, however, must be done in a supplement.]

ERRATA.

In Part II., *Proceedings*, Vol. XXII., p. 300, line 11 (Reprint, p. 6, line 11)—*for* Birckmann, *read* Beckmann.

In Part III., *Proceedings*, Vol. XXIII., § 16, line 8—*for* non in ho trovato, *read* non ui ho trovato.

XIV.—*On the Abbeys and Cathedrals of Scotland.*

By P. MACGREGOR CHALMERS, F.S.A.Scot., Architect.

[Read before the Architectural Section, 5th March, 1894.]

THERE is only one reliable guide in the study of the History of the Ecclesiastical Architecture of Scotland. Local tradition is often interesting, but, as a fabric reared by memory and imagination, it can aid us but little where scientific accuracy is desired. It might be thought that in the mass of literature on the subject published since Scott revived the dying interest of Scotchmen in the beauty of their own country and in its history, there would be found all the material necessary for the history of our old abbeys and cathedrals. But a somewhat extensive acquaintance with that literature convinces one that, in very few instances, is the printed page more than a record of local traditions. The writers generally have been men of culture; but, with very few exceptions, they have had no knowledge of art. They stumble and fall at every turning. We find no parallel to this in the modern literature of science, and yet art is as practical as science.

When we turn to ancient charters and documents we may be readily lulled into the belief that we have at last found a sure foundation. But many a wreck can be traced to trust in a defective compass; and the written page of long ago has been a most prolific source of error. A charter runs that King David I. founded the Abbey of Melrose. The charter is true, but shall we see King David's work, as we are sometimes told, when we visit the beautiful shrine to-day; and shall we gaze on his statue and that of his queen, as they sit perched on their throne in the apex of the east gable? King David's work has long since passed away, and the statues are those of later monarchs. The charter cannot aid us here. But we shall find a better illustration nearer home, in our own Cathedral of Glasgow.

One of the most interesting chapters in the history of that building relates to the tower. Nothing that is known of Bishop Robert Wishart is more characteristic than his acceptance of a

present of timber from King Edward I. of England, in 1291, to enable him to complete the tower of his cathedral, and his misapplying the gift to the construction of engines with which to batter the English in the Castle of Kirkintilloch. The record of a later time is that the tower was destroyed about the year 1400, and that it was rebuilt soon after by Bishop Lauder. The present central tower bears the arms of Lauder. Then, we are told that the tower which Wishart erected was the central tower, and, as a necessary sequel to this, the nave is said to have been erected in the thirteenth century. This is the statement accepted at the present moment. But allow the mind to harbour a doubt—the nave completed at the end of the thirteenth century? Then not a single stone was laid for about 130 years, although all that remained to complete the great fabric was the comparatively insignificant structure at the north-east corner of the building—the very necessary chapter-house and sacristy. Again, for what purpose was the nave erected? Was it to stand, as it does to-day—a barren wilderness—or was it intended for the worship of the faithful who should gather round its sacred altars? Surely it was built for some useful purpose; and yet we are asked to believe that it stood empty for more than one hundred years, as there is no record of the dedication of any altars until the beginning of the fifteenth century. What, then, was this thirteenth-century tower? In a study of this point made some time ago, which will shortly be published, it has been conclusively proved that the tower erected by Wishart and restored by Lauder was the north-western tower, so foolishly removed sixty years ago. The nave is fourteenth-century work. Thus it will be seen that a charter of itself is but a poor guide.

It was a favourite practice in the olden time for the local magnate or the chief prelate to have his name or arms carved on the building erected or restored by him, and thus to preserve the record of his act of generosity. In many cases these records in stone supply us with the most definite information regarding the age of the work. Frequently they are the only source from which we draw that human interest which gives vitality to our study. But can it always be said that "he who runs may read"? Turn to Glasgow Cathedral again—to the remarkable Aisle of Car Fergus,—the lower storey of a never-completed south transept. This is popularly known as Blackader's Crypt, and that archbishop's arms may be found on two buttresses on the exterior,

and on the groined roof in the interior. Of this building it has recently been written: "Anyone unfamiliar with the later Scotch styles, and who did not know that this crypt was erected by Bishop Blackader in the sixteenth century, would be very much puzzled by this building. It is as unlike English work of the same period as can well be imagined. At first sight—looking at the outside of it,—one would say that it was Early English. The builders seem to have done their best to copy from the adjoining crypt; the plan of the window jambs is very much the same, and even the mouldings, but I have never seen an instance where a late workman has managed to make an early capital or base. The late work is sure to be detected there, if nowhere else; and here, as both can be seen from the same spot, it is interesting to compare the one with the other."

Let this statement be subjected to the criticism which it richly merits. We are asked to believe that the artist, working about the year 1500, in order to secure some appearance of uniformity, deliberately copied not only the general design, but also the very delicate mouldings of his predecessor's work of 250 years before, in walls and piers, which are comparatively obscure, but that, when he came to the more prominent and attractive carving and the great vaulted roof which bulks so largely in the eye, he relapsed into the style of his own day. Nor can it be omitted that at the very moment when this desire for uniformity is supposed to have existed, the rood screen—standing in the very centre of the great church, and the observed of all observers—was erected in a style true to its own period, and utterly unlike its surroundings. That there was imitation of early forms, for the sake of unity of design in this case, or in any case in Scotland, cannot be maintained. Had there been a more careful examination, the difference referred to in the mouldings of capital or base would have been seen to be non-existent, and it would have been recognised that the resemblance of this building to thirteenth-century work was due to the fact that it *is* thirteenth-century work. To maintain otherwise would compel us to assert that the supposed copyist stamped almost every stone of walls and piers with the mason's marks of the thirteenth century, and that, when he came to the carving, and the groined roof, and to the rood screen, he omitted them altogether, and in this was again true to his peculiar habit.

The arms of Archbishop Blackader are not a record of building, but only of restoration. From this illustration it will

be seen that the presence of name or arms is not an infallible guide to us in our study. That infallible guide we must secure in the art itself. In whatever field of study we may search, in the history of literature, of science, or of art, we shall always find that every work to the production of which man has devoted the best of mind and hand is indelibly stamped with the impress of his own individuality and of his time. The distance that separates a Caedmon or Alfred from a Swinburne or Henley may be bridged, and each arch stone will be a poem. So is it with architecture. The Christian architecture of the Romans, as first introduced into Britain, was far removed from, and had little in common with, the delicate Gothic work of the end of the fifteenth century, and yet the progress from the one to the other was certain and steady. Only by the aid of the art itself, in all its minute changes, can we hope to travel the road that lies over these 1,200 years.

Mr. Chalmers afterwards exhibited a series of limelight views, covering the country from Kirkwall to Durham, and from St. Andrews to Iona, and arranged in chronological order. Beginning with the best authenticated site of St. Ninian's "White House" at Whithorn, the early MSS., and crosses, the progress of the art was shown from the Church of St. Regulus at St. Andrews, of the middle of the eleventh century; through the twelfth century, as in Durham, Dunfermline, and Jedburgh; the thirteenth century, as in Glasgow; the fourteenth century, as in Melrose; the fifteenth, as in Linlithgow, Roslin, and Lincluden, until the author came to the work of the early sixteenth century, as in Paisley, when the art was engulphed in the Reformation.

XV.—*On Dynamo-Electric Machinery.* By W. B. Sayers, M.Inst.E.E.

[Read before the Society, 21st March, 1894.]

Synopsis of Paper:—(A) Electro-Magnet—Magnetic Field—Solenoid—Interaction between a Magnet and a Conductor conveying an Electric Current — Electro-magnetic Induction. (B) The Dynamo (1) as Generator, (2) as Motor—Some Recent Improvements.

(Plates XI. and XII.)

Magnetic and electric actions are concurrent phenomena. It is possible to have magnetism without the demonstrable presence of electricity, and it is possible to have electricity without the demonstrable presence of consequent magnetism. But in each case the phenomenon is static; as soon as ever we have relative motion—as soon as ever we enter the domain of dynamics—the two phenomena become concurrent.

Magnetic change causes electric displacement, electricity in motion generates magnetic *lines of force.* As an example of magnetism without the demonstrable presence of electricity, we have the permanent magnet and the phenomenon of terrestrial magnetism. As an example of electricity without consequent magnetism, we have the phenomenon of the static charge. The subject of my paper, however, is dynamical, and I, therefore, leave the domain of statics without taking up more of your time.

Electrical action is a phenomenon due to an unknown cause, subject only to the general laws of dynamics. It was so regarded by Professor Clerk-Maxwell in his celebrated treatise on "Electricity and Magnetism"—published, I think, in 1873; and while it would be undoubtedly wrong to say that during the intervening twenty years no progress had been made towards the discovery of the true nature of electricity, yet even the fundamental question as to whether it is a material substance or otherwise is at present unanswered. I think even Professor Blyth, whom we had the pleasure of hearing in this room on

"Electricity and Ether" last winter, will bear me out that this is actually the case, though both he and other distinguished philosophers, whose names it is unnecessary for me to mention to a Glasgow audience, hold elaborate theories more or less developed, based on observed facts, on the nature of electrical action.

Fifty or sixty years ago a similar uncertainty existed, I suppose, with regard to the nature of heat, but the answer to this has long been settled to a certainty by Carnot, Tyndall, and others, and heat is now known to be not a material, but, in Professor Tyndall's words, "a mode of motion."

Although I am, of course, aware that a large number of those present are as familiar with my subject as I am myself, it has been thought that a demonstration of a few of the underlying principles on which dynamo machines depend would be interesting to many, and I will, therefore, endeavour to explain, by the aid of this apparatus—which has been kindly placed at my disposal by Messrs. Mavor & Coulson, and the electric current, which Mr. Arnot, the City Electrician, has provided from the street electricity mains,—what electricity is to practical engineers; and I think I shall not be far wrong if I describe it as *a vehicle of energy*—that is to say, something capable of transmitting energy, or the power to do work, to a distance, or of applying energy in a manner peculiar to itself, as, for instance, in electrolytic action. Now, I wish to emphasise the fact that in all the varied uses to which electricity is applied, its function is either to convey or apply energy, or to do both of these things—that is to say, to overcome opposing forces or resistances of one kind or another. In many cases the amount of energy conveyed may be infinitesimal, and in these the peculiar and valuable feature is the manner in which the energy is applied—as, for instance, in causing the diaphragm of a telephone to vibrate so as to produce, with incredible accuracy, all the varying tones of the human voice. In other cases the amount of energy may be enormous, amounting to many thousands of horse-power. But there is not a single practical application of electricity in which the electric current itself is used up or absorbed in any way whatever. The same quantity of electricity returns to the Corporation Lighting Station in Waterloo Street as leaves it, and the sole function of the steam boilers, engines, dynamos, &c., is to produce energy in the form in which it can be conveyed to the consumers' lamps or motors, or other appliances. Given a suitable electric supply, it

can be made to deliver up its energy in any of the forms of which energy is susceptible—in the form of heat, of heat and light (for, Mr. Tesla notwithstanding, we do not yet know how to produce light for practical purposes without heat), or in the form of chemical action.

The salient feature about an electric supply is this, that it constitutes a supply of readily convertible energy, and convertible, too, with very high economy, without the aid of material in motion, as is the case with shafting and gearing, compressed air, and hydraulic power; or of local combustion, with its attendant inconvenience in the shape of noxious products, such as the exhaust, in the case of a gas engine. We obtain from the electric supply, with the aid of comparatively inexpensive appliances, light, heat, power, or electro-chemical work. These are attributes of the electric supply which we, who are engaged in the electrical engineering profession, feel have only to be known to be appreciated and taken advantage of by the public. It is outside of the scope of my paper to-night to go into the question of relative costs of electrical and other means for doing various kinds of work, so I will only say in this connection that the price which it is at present necessary for electric supply stations to charge undoubtedly limits, to some extent, the uses to which it can be economically applied; but when energy is required for any purpose, and an electric supply exists, and even in many cases where there is no such supply, the question of using electrical energy should be carefully gone into. In many cases it would be found, as is undoubtedly the case with electric lighting, that although the actual amount of the bill for electrical energy may be greater than would be the bill for coal or gas for performing the same work, yet, on account of its great convenience, its cleanliness, its possibilities of artistic beauty, and its healthfulness when applied to lighting, the result would be highly economical in the long run.

For the purposes of the practical engineer, then, electricity may be compared with the water in a hydraulic system, or to an endless belt or rope. It conveys the power generated by a steam engine, or other prime mover, to the place where it is required. The analogy which exists between hydraulics and electro-dynamics, as well as some of the various systems of electric distribution which have been devised, has been carefully followed out by Mr. H. A. Mavor in his paper on "Public Lighting by Electricity," read before this Society on 19th March, 1890.

Proceedings of Philosophical Society of Glasgow 1893-94, Plate XI, Vol XXV.

ILLUSTRATING PAPER ON DYNAMO MACHINES.

Fig. 1.

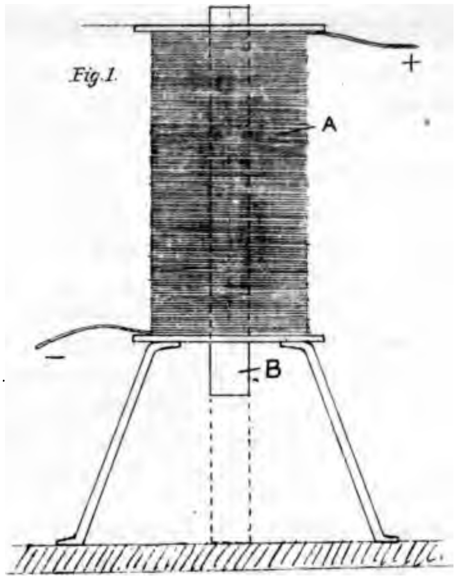


Fig. 2.

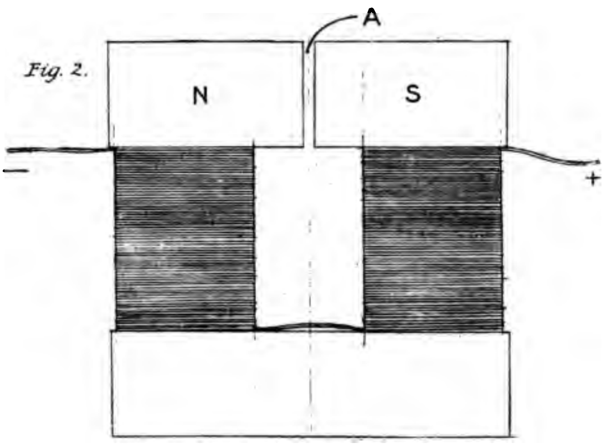


Fig. 3.

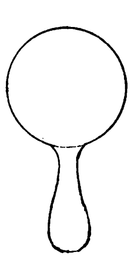


Fig. 4.

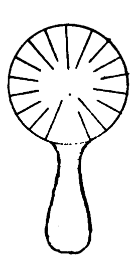
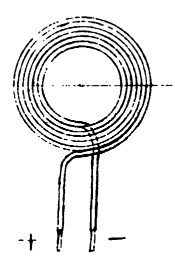


Fig. 5.



MACLURE, MACDONALD & Co. LITHRS GLASGOW.

I will now proceed, with the aid of some simple experiments, to illustrate the principles on which the action of dynamo-electric machines depend.

ELECTRO-MAGNETIC EXPERIMENTS AND DESCRIPTION OF SAME.

A conductor conveying an electric current was shown to deflect a compass needle, also to magnetise small pieces of iron placed close to it, so that a small ring of iron filings would cling together around it. The conductor was also observed to be slightly warmed by the passage of the current. The current through the conductor was then greatly increased, the conductor being thereby raised to a white heat, and ultimately fused.

The multiplication of the magnetic effect, by coiling the conductor into a helix, was next illustrated by means of a *solenoid*. (See Plate XI., Fig. 1, A.) When the current was turned on, the iron core, B, was raised off the table, being magnetised and also drawn into the centre of the solenoid by electro-magnetic attraction set up by the current flowing through its coils.

A powerful electro-magnet, having a narrow aperture between its poles (A, Fig. 2), was next energised, so that a powerful *magnetic field* was set up in the aperture A. It was next shown that a piece of thin wood, of the form of Fig. 3, was unaffected by the existence of the magnetic field, but that a copper blade of the same form could not be suddenly thrust into the aperture, or suddenly removed from it, though slow motion was hardly resisted at all. This effect was due to powerful electric currents set up in the copper during its motion at right angles to the magnetic lines of force. Another copper blade, similar to Fig. 3, but slit radially —as shown in Fig. 4,—was found to exhibit the last effect to a very much less degree, owing to the discontinuity of the copper in a circular direction, which had the effect of dividing up the *induced current* into a number of smaller eddies, of much smaller aggregate volume than the single swirl set up in the solid blade.

A flat coil of insulated wire (Fig. 5) was next thrust into the aperture A (Fig. 2), and was shown to be practically unaffected so long as the ends of the coil were separated. When the ends of the coil were connected together, it was found to resist rapid motion through the aperture, in the same manner as the solid disc, due to the current generated in its coils when the circuit was complete. The two ends of the coil being joined by a very fine wire, this was fused by the current generated when the coil

was suddenly snatched out from the magnetic field. This illustrated the principle on which the dynamo machine (generator) is constructed.

The coil (Fig. 5) was next connected to the electric supply, and a powerful current sent through it. The coil was now powerfully pulled into the aperture if the current was circulating in one direction, and was powerfully repulsed when the current was in the other direction. Reversal of the magnetic polarity also caused reversal of the effect of the coil with the current circulating in it. This illustrated the principle upon which electric motors operate.

An electro-motor capable of transmitting five horse-power was next exhibited running "light."

Two ordinary 16 candle-power incandescent lamps were connected to the supply, and the pressure on their terminals, which was at first normal, was gradually increased until it was at last double the normal, the lamps giving light equal to about 200 candles each. The lamps broke after a minute or two at this pressure, but the experiment showed that it was possible to obtain a far greater amount of light by the expenditure of a given amount of electrical energy than is practicable with the best lamps yet produced.

Description of Dynamo-Electric Machine.

A dynamo-electric machine, then, is a machine in which the principles I have illustrated are utilised, either to *generate* an electric current by means of mechanical power, or to *transform* the energy of an electric current into mechanical power. It consists essentially (1) of a powerful electro-magnet, which, in the machines I have here, is stationary; and (2) of a number of coils of insulated conductor mounted upon a spindle so as to be capable of rotation. The electro-magnet has come to be technically known as the *field magnet*, and the portion on which the insulated conductors are mounted as the *armature*.

In order to obtain a continuous current of a greater pressure, or E.M.F., than is practicable with a single conductor, it is necessary to use a number of coils, and to connect these to a device for changing the connections as the rotation proceeds. This device consists of what is called a *commutator*, with its attendant *brushes*.

In the early days of dynamo-electric machines the field magnet was of the permanent kind, made of tempered steel, and the

armature consisted of a number of independent coils of wire, whose ends were connected to insulated plates of metal, forming the commutator, upon which the brushes for conveying the electric current pressed. Such machines were made by Del Negro, Pixii, Pulvermacher, Woolrich, Wilde, Varley, and a number of others.* The currents delivered by these early machines, however, although always in the same direction, were intermittent, or varied periodically in strength; but, in 1864, Pacinotti devised a form of armature in which the coils were joined into a continuous conductor, connected at intervals to insulated segmental plates, and were so arranged that, instead of the whole coil, which was for the moment generating the electric current, suddenly becoming disconnected and replaced by another by means of the commutating device, the whole series of coils were continuously in circuit, and a large proportion of them always effective. In this way the necessary commutation or reversal was effected on those sections or coils which were, for the time being, non-effective, owing to their position relatively to the field-magnet poles. Thus, by employing a sufficiently large number of commutator plates, with their connections to the armature winding or coils, a practically continuous current was obtained. This method of winding of armatures is the one now universally adopted for continuous-current machines, with the exception of the larger number of those used for high-tension series arc-lighting, which are still made with "open" or independent coils. Pacinotti also first used armature cores in which the coils are wound into notches or grooves, such as those you see on the table to-night.

In 1870, Gramme independently invented the method of winding armatures which I have described, and he was, for a long time, credited with having been the first to use such a method—Pacinotti's invention having, by some oversight, been unknown to the scientific world until after that date.

Pacinotti and Gramme both used ring armatures—that is to say, instead of using a core made in the form of a solid drum or cylinder, as is the case with these armatures, they used a ring, and wound the conductors over the surface and through the centre, a practice which is still very largely adopted, and has advantages in some cases, over drum or cylinder armatures. The drum-armature winding was invented by Hefner von Alteneck, and is

* See "Dynamo-Electric Machinery:" S. P. Thompson.

in effect the same as the Gramme or Pacinotti winding, the difference being that the coils, instead of being wound over the surface and through the centre of a ring, are wound upon the surface and over the ends of a cylinder. I have said that in the first machines permanent steel magnets were used, but, on January 17th, 1867, Dr. Werner Siemens described to the Berlin Academy a machine on the self-exciting principle—that is to say, the machine was provided with an electro-magnet furnished with current from its own armature, and Siemens, to mark the event, coined the name "dynamo-electric machine." On the same day* that this paper was communicated to the Royal Society—February 14th, 1867—a paper was read by Sir C. Wheatstone making an almost identical suggestion, but with this difference that, whilst Siemens proposed that the exciting coils should be in the main circuit, Wheatstone proposed that they should be of high resistance and connected as a shunt. There occurred, then, this extraordinary coincidence, that the two kinds of self-exciting dynamos which have since been in use—namely, the *shunt machine,* whose characteristic is a practically constant pressure with varying external current, and the *series machine,* whose characteristic is more nearly a constant current with varying pressure, both of them using the same principle—were independently invented and were actually communicated on the same day to the Royal Society.

In the earlier days of the dynamo-electric machine—for we are, I think, still in the "early" days—electrical engineers had their attention very forcibly drawn to the problem of getting rid of the sparking which occurred at the commutator. This sparking, though very pretty, and constituting, as it did, the great point of attraction and interest to the uninitiated, was found to destroy both commutator and brushes at a rate which was beyond endurance. It was no very unusual thing then for a machine to eat up a pair of brushes in a night's run. But, with the investigation which the action of the dynamo machine received at the hands of a great number of experts, the cause was explained, and a remedy found in making the field magnet very large and powerful, so as to be little affected by the current in the armature.

For the commutation to be effected without sparking, it was found that the strength of the magnetic field near the edge of the leading pole-tip must not be below a certain value relatively to

* "Dynamo-Electric Machinery:" S. P. Thompson.

the magnetising power of the armature. Now, it so happens that the strength of the field near this pole-tip is reduced by the reaction of the current in the armature, while the opposite pole-tip is strengthened by the same reaction. The more current taken from the armature the greater the reaction and the greater weakening of the leading pole-tip, so that, unless the field magnets are made sufficiently large and powerful to be little affected by the armature reaction, a point is soon reached when the leading pole-tip is too weak to perform the function necessary to avoid sparking—that is to say, the function of arresting and restarting in the opposite direction the current in the armature section to be commutated, in a manner analogous to the action of steam in a well-constructed steam engine in arresting the motion of the piston and connecting rod, &c., and restarting them in the opposite direction, and so avoiding "knocking." Again, in order that sparking should be avoided, it is found necessary in most machines to shift the brushes with every change of load, in order to get the coil under process of commutation into a position nearer to, or further from, the leading pole-tip, according as to whether the change is an increase or decrease in the load.

SOME RECENT IMPROVEMENTS IN THE DYNAMO.

In the spring of last year I had the honour of reading a paper before the Institution of Electrical Engineers in London on a method of controlling the sparking at the commutators of dynamo-electric machines without the necessity for making the field magnet so large and powerful, relatively to the armature, as I have indicated had been hitherto necessary. This method consists in connecting the commutator segments to the main winding of the armature, through conductors which first pass over or around the armature, in such a relation to the coils between which they are connected that they can be acted on by the trailing pole-tip, which, as I have explained, is strengthened by the armature reaction, instead of being weakened. With this arrangement the more current taken from the armature the greater the strength of the magnetic field, which is instrumental in producing the sparkless commutation of the armature sections. Not only so, but, in addition, whereas the only position in which the brushes could be set in ordinary machines, while securing sparklessness, was such that the total effect of the armature reaction was to weaken the effective magnetic field, besides distorting it in a disadvantageous

manner as regards the commutation, with my device it has been found practicable to perform the commutation in such a position that the total effect of armature reaction is to strengthen the effective field, while the distortion becomes advantageous, in respect that it causes an increase in the strength of the magnetic field at the part which is effective in causing the sparkless reversal of the armature sections. By this means, then, we have gained two substantial advantages.

1. We have reduced by from 25 per cent. to 50 per cent. the weight, and, at the same time, the cost of machines.

2. We have done away with the necessity for shifting the brushes with varying loads, and thus have very materially reduced the amount of attention required.

The extent to which the advantage of being able to make the armature reaction strengthen the field can be turned to account is illustrated by the fact that we have made a machine in which the armature sets up its own field, thus dispensing with winding upon the magnets or "keepers," as we then call them, altogether. This machine is illustrated by the diagram on the board. (See Fig. 6, Plate XII.)

As this machine is the first ever made to be self-exciting by means of the armature reaction only, the following brief description (taken from the *Journal of the Proceedings of the Institution of Electrical Engineers*, Vol. XXII.) may be of interest. In the diagram, Fig. 6, A represents the armature; B B are the iron "keepers;" C represents commutator plates; and D indicates the brushes.

Particulars and dimensions of the machine are as follow :—

ARMATURE—RING FORM.

Diameter, external, - - - - - -	$9\frac{5}{8}$ in.
,, internal, - - - - - -	$4\frac{1}{4}$,,
Length, - - - - - - - -	9 ,,

The periphery has forty slots cut into it in which the conductors are placed. The slots are $\frac{3}{4}$ in. deep, $\frac{1}{4}$ in. wide, and each has two grooves cut in it opposite to each other near the top. The main winding conductor is of copper strip, 0·15 × 0·5 in., and occupies the space in the slot below the grooves. The commutator coils or bars are of copper, 0·1 in. × 0·3 in., with rounded edges, insulated D.C.C., then double-lap tape. They are slid into the slot from one end, their edges fitting into the two grooves.

Illustrating Paper on Dynamo Machines.

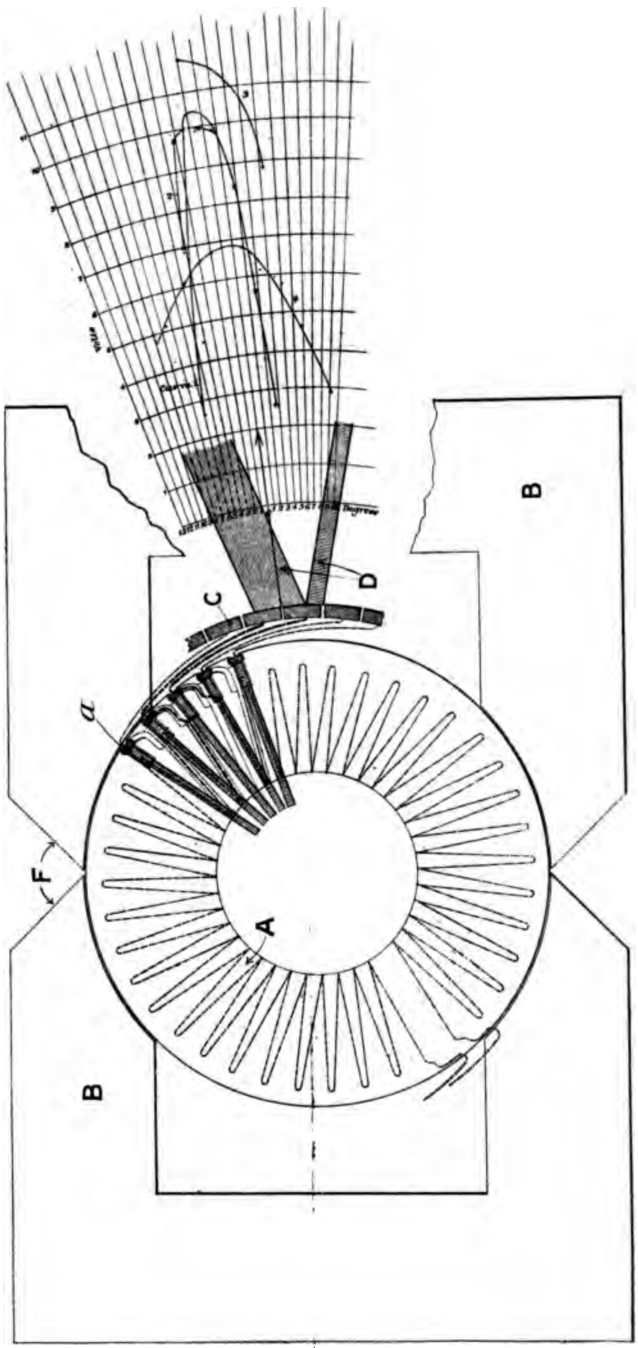


Fig 6.
Diagrammatic representation of Dynamo without winding on Magnets.

Maclure Macdonald & Co. Lith.rs Glasgow.

(See *a*, Fig. 6.) Thus they serve to hold the conductors in position, and so obviate the necessity for binding. The air space is 1 millimetre.

The keepers (they really are not field magnets) are of double-L shape, and made up of charcoal iron plates to prevent heating from the variation of the flux over the polar surface caused by the slots in the armature. They are separated in the centre in order to reduce the cross induction, which is, of course, very considerable.

I have had in mind trying Professor S. P. Thompson's suggestion of making up the keepers—or field-magnets, as the case may be—of separate plates, with the object of reducing cross induction. In subsequent machines the necessity for laminating the polar surfaces has been obviated by putting the conductors into tunnels, and only running a saw-drift through the crown of the tunnel to break the iron circuit and reduce the self-induction of the section; the well-known device of winding over with charcoal iron wire has also been used.

On testing the machine illustrated in Fig. 6, it was found to be self-exciting, as I expected, and it will carry a current of 400 amperes at 14 volts running at 900 revolutions per minute. It is capable of running with this current *absolutely without spark at the brushes.* There is hardly any external field—sufficient, of course, to move a compass, but hardly enough to feel with a piece of iron—except between the two keepers in the space marked F, where there was considerable field, due, of course, to cross induction.

The most remarkable feature observed about the machine when self-exciting is its extreme sensitiveness with regard to the position of the brushes, a very small movement causing a great variation in the volts. Moreover, it will not excite at all unless the brushes are within a certain arc of about 9 degrees—the position of this arc corresponding with the position in which the hindermost commutator bar under the brush is under the pole-tip, and the foremost one has passed out from under it.

The curves to the right of the brush in Fig. 6 represent the volts observed with the brushes in various positions. The pointer drawn through the brush indicates the point in the curve corresponding with the brushes in the position shown. Thus, if the brush and pointer were shifted in either direction, the pointer would indicate the volts corresponding with the position of the brush.

Tables of Results.

I.

Speed.	E.M.F.	Current.	Position of Brushes.*	Remarks.
1,019	11·2	291	− 2°	Slight sparking.
1,000	8·35	217	+ 0·8°	Sparkless.
1,055	4·68	175	− 4°	,,
1,062	2·83	78·14	− 6°	,,

* The zero position of brushes is indicated in the diagram Fig. 6. The sign + in front of the figures indicates that the brushes were in front of the zero position, the sign − that they were behind the zero position, relatively to the direction of rotation.

II.

All Results are Means of Three Readings.

Speed.	E.M.F.	Current.	Position of Brushes.	Remarks.
847	5·6	189	+ 1°	Sparkless.
850	8·35	289	+ 0·8°	,,
850	9·9	321	− 0·4°	Slight sparking.
850	10	340	− 1·3°	,, ,,
850	9·7	326	− 3·2°	Sparking.
850	7·1	237	− 4°	—

III.

Speed.	E.M.F.	Current.	Position of Brushes.	Remarks.
1,016	12·1	265	− 2°	Sparkless.
1,032	9·2	202	+ 3·2°	,,

IV.

Means of Three Readings.

Speed.	E.M.F.	Current.	Position of Brushes.	Remarks.
991	6·1	200	+ 2·3°	Sparkless.
996	5·66	199	+ 4°	Slight sparking.
1,005	4·6	199	+ 5·8°	More sparking.
1,013	2·92	194	+ 9°	Slight sparking.
984	6·7	204	+ 0·8°	Sparkless.
991	6·78	207	− 2°	Slight sparking.
994	6·1	206	− 5°	More sparking.
1,002	5·21	204	− 7·5°	Sparking under brushes.
988	4·86	205	− 9°*	Slightly more.

* If moved farther back, serious sparking occurs, so that the carbon brush gets red hot.

It will at once be obvious to all that a shunt machine with armature on my principle may be made to keep pressure constant with varying current, as part of the armature winding performs the function hitherto performed by the use of series coils on the magnets. As would be expected, the armature coils so used are several times more effective, turn for turn, than an equal number of series coils upon the magnets. First, they count double, because they would exist as *back*-turns if the machines were running with a forward lead; and, second, because, whereas in the latter case the effect of the series coils—or, rather, of the remainder of them after subtracting the number of the back-turns—depends upon the permeability of the field magnets and armature, and all magnetic leakage is, of course, ineffective, the action of the *forward*-turns on the armature when running with a backward lead, though depending on permeability of the armature core and magnets, is wholly effective, even the leakage (if we so call the lines which do not pass around the magnet cores) being necessarily cut by the conductors on the armature.

By utilising the armature reaction, which in the machine just described constitutes the sole exciting force, we are able to make self-regulating machines without the necessity for providing the magnets with series winding.

XVI.—*Some Important Sanitary Problems.* By Mr. James Chalmers, I.A., President of the Sanitary and Social Economy Section.

[Read before the Society, 13th December, 1893.]

I propose this evening to direct your attention, and, through you, that of the authorities in charge of rural and, more especially, of urban sanitation, to the presence of waste matter, which has an important bearing upon the origin and spread of disease, and which it is their duty and privilege to remove. I refer more particularly to waste matter in our streets, courts, ashpits, sewers, drains, and graveyards, which falls to be dealt with by the Health Committee of this and other cities.

In dealing with the sanitary aspect of micro-organisms present in vegetable matter undergoing decay, it is necessary to keep in view that they may exist under certain conditions, and yet be practically harmless, as, for instance, when they are rendered sterile by low temperature, when their virulent character and work are neutralised by other organisms, or by the presence of an abundant supply of pure air. It is desirable, however, that the practical sanitarian, especially if he be a responsible official of a Health Department, should assume that virulent micro-organisms are present in waste matters undergoing decay, and to recognise the fact that, as putrefactive fermentation proceeds, the number, as also the power, of these organisms rapidly increases, and becomes a menace to the health of any one who has contact with them. The question naturally arises, therefore, Under what conditions does vegetable matter undergo rapid putrefactive fermentation? It is evident that the efficiency and consequent success of any cleansing or sanitary operations will depend upon the degree to which these favourable conditions are rendered impossible. These conditions consist mainly of the matter undergoing putrefactive fermentation being mixed with water, having a somewhat high temperature, or confined in a small or ill-ventilated space. These three points are all-important to the practical sanitarian.

Taking, first of all, the waste matter in our streets, courts, and ashpits, which are under the charge of the Cleansing Department, we will consider the quantity requiring to be removed by it, and, after examining the character of the material, consider whether or not, or to what extent, it may be said to be removed before putrefactive fermentation has assumed a degree dangerous to health; and we will naturally examine it with the greatest care where it may be found to be moist in character, of a more or less elevated temperature, and in a confined and ill-ventilated space.

Taking the Statement of the Revenue and Expenditure for the year ending 31st May, 1893, prepared by Mr. Young, Inspector of Cleansing, and issued by the Police Commissioners, I find that the average per working day was 1,157 tons, and the total 361,016 tons 0¼ cwts., thus made up:—

	Tons.	Cwts.
1. Household Refuse and Night Soil, ...	192,595	4
2. Street Sweepings, ...	54,243	8½
3. Long or Stable Manure, ...	14,862	6½
4. Snow, ...	18,564	
5. Rubbish and Mud, ...	80,751	1¼

We might, I think, divide this matter, into two kinds—what is removed before fermentation has taken place to a degree dangerous to health, and what has been allowed to remain until putrefaction is so far advanced that it may fairly be said that the gases evolved are of a virulent or dangerous character.

With the exception of the household refuse or night soil, I think we may safely hold that the whole material described comes under the kind considered as not dangerous to health, although conditions may sometimes exist where this is not so. The principal streets are swept daily by a staff of 284 men, and, in addition to the cleansing which they receive from the rainfall, over 41 million gallons of water was spread on them during the year. The only danger that might arise would be in the more private streets, which are not swept daily, and this would only be serious where the manure was from cattle suffering from a disease communicable to man; but as I am not aware of any of our Medical Officers entertaining any apprehension from this source, I will simply suggest it, and assume that, even although such manure did exist, the open character of the streets, with the consequent aëration, would dilute the gas to an extent quite harmless. In this connection I may point out that wood-block paving, however desirable from the absence of noise of traffic that it affords,

is certainly entitled to the closest scrutiny and criticism, as it is not impervious to moisture, and is not washed by rain or water with the same effect as in the case of granite or other stone paving, and will give out the gases from putrefaction in a greater degree, simply because it does not so readily part with the agents of fermentation. Buchanan Street, for example, may have many attractions for pedestrians, but I am afraid that, as regards its freedom from gases evolved from street liquid and solid manure, particularly the former, it should be the most unhealthy street we have, especially in close weather. Some analysis on this point would be of value.

Coming now to the matter in which we may reasonably hold that putrefactive fermentation goes on in a degree dangerous to health, the question arises, How much of the 192,595 tons of household refuse and night soil may be held to be generating gases of an injurious character? You may be aware that, in certain districts of the city, the dust cart removes the refuse daily on the bucket or pail system, but for the bulk of the city, the districts are so arranged that the contents of each ashpit are removed, or ought to be removed, once a week. Previous to this arrangement, it was usual for the day scavengers to report when an ashpit was full, and the night men were then told off to remove the refuse. The practical objection was found to be in scattering the men all over the city to these detached ashpits, and there is no doubt but that, from a sanitary point of view, the district arrangement, so far as it guarantees a weekly cleansing, is much more satisfactory. Now, in considering the condition of ashpits in relation to disease, we must be content to lay down the proposition "that their contents ought to be removed before they can produce putrefactive fermentation;" and, in considering the conditions, character, and kind of material in the ashpits in the various classes of houses, our conclusion would be that, if at all possible, the present system should be abolished in favour of a daily removal arrangement, especially in old properties and corner tenements. Dividing the total of 192,595 tons of household refuse and night soil by the number of weeks, we get 3,704 tons per week lying in the ashpits of the city, some of it at least a week old. Consider what the contents of the ashpits consist of. You have the sweepings of the houses, waste vegetables, waste meats, fresh night soil, particularly where there are no water-closets, mixed with waste or rain water, and covered over with warm ashes, which tend to raise

the temperature of the mass. Can you conceive of conditions better fitted to produce putrefactive fermentation? You have all the essentials—solids, water, and heat, confined in a restricted space.

The new Building Regulations Act contains a by-law (63) to the effect that no ashpit shall be placed nearer to any dwelling-house or occupied apartment than 12 feet, or connected with any cesspool, drain, or common sewer; but ashpits for corner tenements may be placed where the limits of the ground will allow, being not nearer to any dwelling-house or occupied apartment than 6 feet, and existing ashpits may be repaired or rebuilt on the same site where the owner cannot, within the limits of his ground, remove them to a distance of 12 feet.

This provision does not touch the question of the present ashpits, many of which are directly attached to the walls of dwelling-houses, which, indeed, form one or more of the walls, and, in any case, when we consider that the gases evolved from the waste matter undergoing putrefactive fermentation may contain the germs of zymotic disease when it is present in any of the houses, we may safely conclude that both the 6 feet and 12 feet provisions are inadequate. Taking also the narrow courts in which are situated many of the houses occupied by the poor, now that water-closets and a pure water supply have been introduced, I think I am justified in saying that but for the offensive odours from the ashpit, the blocks, or, at least, the courts or squares behind them, would contain comparatively pure air. Indeed, when we consider the very large sums which many proprietors have spent upon sanitary improvements, and that the remaining nuisance is the waste matter left by the Cleansing Department in the ashpits, I am surprised that the Health Committee have not yet recognised the fact that they are now the parties at fault. Nature has been very considerate in retarding putrefaction for a period sufficient to admit of the removal of waste matter in a fresh and practically innocuous state, and the parties who are responsible for disease or low vitality from this source are undoubtedly those who delay its removal until it has assumed a condition dangerous to health. I consider, therefore, that the removal of the 3,704 tons of decomposing matter in our ashpits, particularly around the houses of the poorer classes, constitutes a problem which ought to be solved without delay. I would recommend the use of specially constructed moveable receptacles in place of ashpits, consisting of

malleable iron, coated inside with some glazed material, and divided into compartments or sections, so that they could be easily handled or taken to pieces. The best form would be an outer case or frame with folding bars, which would preclude the square compartments or boxes being interfered with by other than the proper authorities. These boxes should be emptied nightly, if possible, or, at most, every second night. This arrangement might require an addition to the 537 men at present employed in manure or domestic scavenging. Although a rearrangement in the working of the Cleansing Department would entail additional expense, it would have the advantage of getting quit of one of the worst agents of putrefactive fermentation in our midst, and would meet the difficulties which the by-laws try to guard against—the evils of the present system, but which bear upon the face of them that conditions exist, particularly in old properties and in corner tenements (the two classes of unsatisfactory properties), which render effective safeguards inoperative. There is scarcely time to discuss the question of the disposal of city refuse by means of destructors. We have three of them—at Kelvinhaugh, and St. Rollox, and on the South-Side—each having from nine to twelve furnaces. Out of the total of 361,000 tons of town refuse, 276,000 tons are distributed over thirteen counties of Scotland, while of the remaining 85,000 tons 15,065 waggon loads were sent to tips as unsaleable refuse.

To any of you who are interested in the method of city refuse disposal, I recommend the perusal of the description of the Powderhall refuse destructor, issued by the Town-Clerk and Burgh Engineer of Edinburgh, where the amount to be disposed of annually is 90,000 tons, or about one-fourth of that of Glasgow; and it is interesting, as bearing upon our subject, to note that, in their report, the Sub-Committee upon this question suggested in 1891 certain leading principles to be adopted with reference to the methods of collection and conveyance of house and street manure. Their recommendations were made after a tour of inquiry through several English towns, viewed in the light of their own requirements:—

(1) All refuse to be collected and disposed of daily, as at present, and to be, so far as possible, classified and assorted, so that such refuse as contained any manurial value, along with street sweepings, would be disposed of for agricultural purposes, and all rubbish and offensive material should be cremated.

(2) The city to be divided into four districts, each to consume its own refuse by means of a destructor which would be capable of dealing with at least one-quarter of the whole city refuse per day.

This Section of the Philosophical Society may commend the Edinburgh recommendation that all refuse be collected and disposed of daily.

I come now to consider sources of putrefactive fermentation from causes other than those which are comprised under the head of city refuse, and the principal agents are the net-work of sewers and drains in our midst. Some of you may remember the importance given in the early years by the Sanitary Section to the discussion of the sewage question, and that then, as now, there was a disposition to mix up what, within the lines of my paper, are two different subjects or departments of the same subject—Sewage and Purification. This resulted in the sanitarians of that time being divided into two camps. Broadly speaking, they were those who considered that the principal object of the sewage scheme was the treatment of it at the outfall, and the other class who held that what was wanted was to keep what we call sewage out of our sewers and drains altogether.

I think that the proper idea of the sewage scheme is simply to remove the sewage before putrefactive fermentation has assumed that stage where it can be considered injurious to health, and the sewage problem is solved when, but not until, we have succeeded in obtaining this necessary result. The East-End scheme, which Mr. Alsing was good enough to explain to us the other day, has a bearing upon this question. Does it at all affect the decomposition taking place in our sewers and drains? Clearly not; it makes no pretence to do this: it simply meets a sentiment in favour of a clean as against a filthy river; it is a purification scheme, and only a sewage question in so far as it obviates or lessens any putrefactive fermentation in the river that can be shown to be injurious to health.

It is interesting to notice that during the first few years of active work in the Sanitary Section very decided opinions were held on the subject, and great attention was given, not only to the various methods of treating sewage at the outfall, but in examining and discussing such filters as Strang's patent, which could be used for the refuse of each house or tenement, clearly showing their anxiety to keep such matter out of the sewers altogether. But

although they were not agreed upon the practicability of keeping sewage out of the drains and sewers, an entry in the minute book, dated 4th April, 1871, shows that, up to a certain point, they were in agreement. The Council met to consider a proposal which the Burgh Commissioners of Bridge of Allan had before them for a sewage scheme, as well as certain letters in the *Scotsman* thereanent by Mr. Phillips, C.E., London, and it was decided to write the Chief Commissioner as follows:—"This Section has, for the last year or two, had this subject discussed before it by some eminent men, and we have come to a very strong opinion that it is a most fatal mistake to run off the rainfall and all the other sewage together, thereby making a larger and unmanageable volume of sewage." The Council then recommended them to weigh the opinions of Mr. Phillips on this subject. This gentleman read a paper before the Section on 9th February, 1872, on the "Sewage of Towns," and contended that, under the system of carrying off the surface water and sewage in impervious fire-clay pipes, there was no possibility of draining the subsoil, while there was a constant discharge of noxious gases into the dwelling-houses. His recommendations included two separate systems of drains—one for surface water and subsoil, the other for the house and sewage drains; the former were to convey the clean water to the Clyde, the other portion to be carried to the sewage farm, where the treatment was to be by filtration and irrigation. Ventilating the sewer and house drains was to be by pipes carried to the roof.

Probably, however, the papers which created the greatest amount of discussion, if I may not say excitement, were the late Dr. Fergus' Presidential Addresses. In his first address, delivered on 13th October, 1871, he traced the prevalence of gastric, typhoid, and other kindred fevers to the foul and noxious condition of the sewers; and in his third address, given on 1st December, 1873, he went further, and attempted to show that since the introduction of water-closets there had been an increase in certain diseases due to excremental pollution. "No one," he said, "who had paid the least attention to sanitary matters would deny that excremental pollution was a powerful agent in the promotion of preventable disease, but sufficient attention had not been given to the fact that, in some diseases generally ascribed to this source, there had been a large increase since the introduction of water-closets." His figures were that —taking diphtheria, for instance—not a single death from that

disease was recorded in England from 1838 till 1851, when it was debited with two deaths per million of the living population; and that a few years later, namely, in 1859, it had risen to 487 per million, and since then had fluctuated considerably, but had never been under 100. The diarrhœal diseases varied before 1847 from 225 to 472 per million, but suddenly rose then to 911, and were, in 1873, 1,211 per million. In some years, known as "cholera years," they were much higher. Of the zymotics not attributable to sewage, there had been a diminution, which might be fairly put to the labours of the sanitarian. He then stated what changes had been made that could account for a slight increase in scarlet fever, a striking increase in the diarrhœal group, and the addition to the list of a most deadly zymotic previously almost unknown. When excremental pollution was known to give rise to these diseases, and then mortality increased after a change more or less complete in our modes of dealing with these matters, it was but a fair inference that the change—no matter how apparently clean, comfortable, and luxurious the people were—must be the cause of the increase.

After an exhaustive examination of the whole subject in relation to air pollution, Dr. Fergus concluded that, if the sewage problem was to be solved at all, it must be by returning to nature's laws, passing the rainfall as speedily as possible into the rivers, and applying the excreta to the soil; and in this connection he pointed out that the Police Board had sold the urine from the public urinals to Mr. Gavin Chapman, who had been collecting it by pneumatic pressure, and subjecting it to chemical action. To do the same with the whole excreta of Glasgow was, he admitted, a vast undertaking, but he was thoroughly convinced that the solution of the problem lay in some such direction, and that already experiments, such as those with Hoey's patent closets, proved that the contents could be collected and removed by pneumatic pressure without the slightest offence, and taken to the country as portable manure. Now, that was the opinion of one of the most distinguished occupants of this chair, and it was formed after a full consideration of the facts bearing upon the subject, and I think we must all admit that—taking the solution of the sewage question to mean the rapid removal of excremental matter before it has reached a degree of putrefactive fermentation injurious to health—the removal of it upon the lines laid down by Dr. Fergus, had it been possible, would have solved both our sewage and purification schemes.

We have, however, changed all that, and the direction in which sanitary reform has gone has been entirely upon defensive lines—creating pollution in our drains and sewers to begin with, and then taking the most elaborate precautions which skill and good material can devise to protect ourselves against the result. It must further be kept in view that, after the river purification system is completed, the sewage problem remains unsolved, unless we are to consider that our preventive measures are quite sufficient.

Now, it is quite evident that, although at this time of day we must take things as we find them, as regards our net-work of drains, it is necessary that we point out in what respect and to what extent the sewers and drains are agents of putrefactive fermentation, and how far we can, at least, still further secure that the excretal matter either be removed at once or before it becomes dangerous to health.

It has been found, from tests made by Mr. Peterkin, of the Office of Public Works, that, in a 5-feet sewer, with a fall of 1 in 1,500, the time taken to convey sewage, with only 10 inches of water, a distance of a mile, was exactly one hour; so that it may be assumed that in sewers, under ordinary conditions, the time taken to convey excrementitious matter from the extremity to the mouth of the sewer, to the outfall, is only a few hours at most. There are, of course, extremely dry seasons, where even 10 inches of water would not always be obtained, and sewers may be comparatively dry; we must keep in view, however, that the main source of gases is the quantity of excrementitious matter which adheres to the sides or high levels of the sewers during floods or exceptional cases of discharge, and which can only disappear by the process of putrefactive fermentation. I take it, therefore, that it is a question of flushing with water in dry seasons before the matter adheres to the sides, or having such a constant change of the air in the sewer that the sewer air may be dangerous in only a very limited degree. It is quite evident that the large increase in water-closets going on in Glasgow for some time will sensibly increase the volume of excrement, while the floods will remain practically the same, and that, therefore, we may expect an increase in the virulence of sewer gas, particularly under the conditions mentioned as common in our present sewers. The worst agent for disengaging gases in sewers is the chemical matter discharged from St. Rollox and other public works, and it is a matter of surprise that up to this time no

effective effort has been made to compel the offenders to adopt other means of disposal of their refuse water than by passing it into the public sewers.

Now, the foregoing remarks suggest the question—Can any practicable system of artificial flushing be adopted which would wash out the sewers both when there is an absence of rainfall and after the great volume of water has left the sides in the filthy condition just mentioned. Any scheme of this kind would require to be thorough in its character to obtain the object aimed at, and would consist of storage tanks between the levels of the sewers and the streets, so placed that they could collect the waste water from the streets or houses, or from the higher levels, and be discharged by syphonage or other means. I think this should be tried on a small scale, as opportunity offers, and "flushing" is certainly both practicable and desirable in the case of house drains. The waste water in the wash-house or other place should be collected in automatic syphon tanks, and discharged at full bore. There is no reason also why our baths should not be made to empty in a similar manner, and I regret that Mr. Honeyman's "Bolton" pipe has not come into use, with its special provision for air flushing, as, along with the flushing tanks, it would absolutely secure that putrefactive fermentation would not take place in our drains to any appreciable extent. It is quite well known that the principal preventive agent, or "sanitary policeman," we employ to guard us against sewer gas is the trap, or water-seal obtained in a trap. I would be unwilling to say anything against this very valuable sanitary article, except to warn you that, while it has the one immense advantage of a water-seal in its general construction, it is a distinct assistance to the agents of putrefaction that it may contain. In discussing the merits of any article which is included in a system, say, of drainage, I think it wise to consider its merits and position in relation to the system of which it forms a part, as well as when it stands alone, for conditions may exist in the former which get quit of the disadvantages or dangers arising from the article itself.

In this connection the objections to a trap diminish when the drains are in constant use, and flushed as I suggest. Assuming that we have 200,000 traps in and around Glasgow, we have simply that number of little cesspools. These hold, in the case of a 6-inch trap, as much sewage as you could hold in a circular vessel 9½ inches in diameter and 7½ inches deep; and in the case of a

9-inch trap, as much as would fill a circular vessel 9 inches diameter, 18 inches high. How do these traps stand as regards the conditions under which putrefactive fermentation takes place? We saw that this is accelerated when the sewage is confined in a comparatively small space, when it is mixed with water, and at an elevated temperature, and it is quite evident that traps are objectionable on all these grounds. I do not think this is so important in view of the contact with the atmosphere at the fresh-air opening at the pavement, but for the fact that, if roof-ventilating pipes act at all, they often act the wrong way, and in place of being outlets for foul air from the drains, they simply serve to give the amount of air required to prevent syphonage after a discharge of a closet or pipe, and the gas generating in the drain and trap is sent out at the fresh-air opening by the force of this discharge, assisted by the pressure of the cold column of air in the soil or discharge pipe. I am quite aware that the sectional system, as it is called, and as required by the new Building Regulations Act, requires traps at the bottom of all the waste-water pipes. I think the Act wisely dispenses with a trap at the bottom of the soil pipe, and is content with the one at the sewer; but if it is thought that the drain-air passes down the fresh-air opening and up any or all of the soil pipes, I think this is a mistake, as exactly the reverse happens. The rule which I lay down in my own practice is that, if an upward current in a ventilating pipe is required, I must make the top of it the hottest part of the whole system, and I must confess that I have only got satisfactory results—some of them exceedingly satisfactory—when I have done this in exceptional cases, and in violation of the city by-laws. As long as pipes are placed outside the external walls, as stipulated in the by-laws, and have consequently a lower temperature than the drain they are required to ventilate, you will never get drain air to go out at the roof; but I frankly admit that the application of surplus heat, as a ventilatory agent to pipes, can only be made in a limited number of cases. Where it is practicable, however, no other arrangement should be tolerated, and the sooner the authorities recognise this the better for efficient ventilation. I may here suggest that, where there is a private installation, the application of electricity is of considerable value, as the heat from a wire placed within a few feet of the top of the soil pipe or ventilating shaft would produce the necessary current while the installation lasted.

I sum up my conclusions as affecting sewage and drainage as follows :—

(*a*) That the main object of a sewage scheme is to dispose of the excrementitious matter with a rapidity which will not permit putrefactive fermentation to take place to a degree injurious to health.

(*b*) That the only complete sewage scheme will deal directly and principally with the problem as affecting the sewers.

(*c*) That the main cause of sewer gas is the adhesion of excrementitious matter to the sides of the sewers left by the flow.

(*d*) That any attempt to overcome this must be by flushing the sewers immediately after their deposit is made, or the gases in the sewers arising from this cause must be sufficiently diluted with air to render them practically harmless.

(*e*) That in the case of house drainage, pipes should be as free from traps and other obstructions as is possible with the prevention of drain-air getting into our houses.

(*f*) That traps, however valuable as water-seals, are simply cesspools, and should only be used where a seal is absolutely necessary.

(*g*) That the drain-air generally escapes at the pavement or ground level.

(*h*) That drains should have a fairly rapid fall, and should be flushed with water by syphons, tanks, or with air, on the principle of Mr. Honeyman's "Bolton" pipe.

I come now to consider the problem in connection with waste matter undergoing putrefactive fermentation in our graveyards. I think, gentlemen, that you may be inclined to take exception to my including the remains of our departed friends or fellow-citizens within the scope of a paper which includes waste matter from our streets, &c., and I will not blame you if you do; but sanitary science makes no exceptions, and you are quite aware that there is no matter so much suspected by the sanitarian as human bodies undergoing decay, especially if containing the germs of contagious

disease. I am afraid, therefore, that unless you can get quit of putrefactive fermentation altogether, the disposal of the dead will remain one of the most important sanitary problems in our midst, and must be embraced in a paper of this kind. The average number of interments in Glasgow and suburbs per annum is about 19,000, and spread over our cemeteries would give an average of about 2,000 each. The ultimate resting-place of a corpse is very much the same as that of waste matter in general; it is simply interred, with this difference, that the remains of our departed friends are surrounded with everything that human love can devise to elevate them, if possible, above that of all other matters undergoing decay. Fortunately, or unfortunately, however, when the funeral party has retired, and a time has come when the number of bodies undergoing decomposition has accumulated until the surrounding air has become impure and an outbreak of disease is feared, then public opinion will insist upon the closing up of the graveyards.

It is not to be wondered at that from time to time sanitarians have raised a warning voice against the continuance of this state of things, and have even gone the length of pleading for the advantages of cremation as getting quit, once and for all, of this earth-to-earth burial, with all the evils which attend it, especially in large towns. But the public generally do not wish to face this discussion or reform in a courageous spirit; they prefer to point to our aristocratic cemeteries, and defy you to prove that they are prejudicial to health; and although you point out that the micro-organisms are present in the body, and, through the agency of earthworms, or by other means, reach to the surface, and, therefore, to the external air, a large portion only adhere to their opinion that a reform in the present mode of burial is sufficient. Well, we must, and are glad to, welcome all who are in any way willing to assist in this reform; but as the sanitary problem in connection with the dead consists in getting thoroughly quit of any agent of putrefaction, we must emphasise the important fact that this can only be done by the purifying process of fire.

Let us see what reform in earth-to-earth burial in Glasgow really means. In 1875, out of 19,237 interments which took place in Glasgow, 9,627, or about 50 per cent., were buried in common ground, and, in order to obtain the needful reform contemplated, according to the rules laid down by the Secretary of State in the Burials Act, you would require 13 acres annually.

Now, you cannot get such an area, nor is it desirable that you should, and no sanitarian has as yet been able to point out how we are to get quit of pit burial by any practical system of earth burial. If this be so, then I have to draw your attention, and that of the Health Committee, to the condition of the pits in which we bury our poor, and to say most emphatically that not only is common decency outraged, but that we have here an enormous mass of matter undergoing putrefactive fermentation under conditions which are, in the highest degree, dangerous to health. These pits are $4\frac{1}{2}$ feet $\times$ 8 feet $\times$ 8 feet deep, containing 16 coffins, or 7 feet 6 inches $\times$ 7 feet 6 inches $\times$ 12 feet, containing as many as 60 coffins. In the interval between the arrival of the bodies for interment the only medium for absorbing the gases is a stratum of a few inches of sand, with the result that in summer it is impossible to keep down the smell.

The condition of our graveyards was brought before this Society in 1886 by Dr. Duncan, and it was remitted to the Council of the Section to take the existing mode of interment into consideration, and take what action they thought proper to remedy the evils in connection with it. The Council took the usual steps of memorialising the Home Secretary, but they were quite aware that, on economic grounds, it was impossible to get quit of the evils connected with the large mass of putrefying matter in common ground unless we were prepared to adopt cremation as a substitute for earth burial. Well, gentlemen, the majority of the Council were prepared to take this step, and the outcome of their deliberations is to be seen in the formation of a Scottish Burial Reform and Cremation Society, and the future progress in this department of sanitary science and public health will be identical with the progress of this new society. We must wish it a successful career, and personally, as one of its founders in 1888, I feel that it is a great privilege to be connected with it.

In the preliminary steps of a movement like cremation, I think that it is well to take a wide and liberal view of its possibilities, and you may remember that, in conjunction with Mr. William Key, I endeavoured to lay before you a scheme of cremation suited to the requirements of this city, in which I sketched out what, in my opinion, would be the practical shape which burial reform ought to take. These opinions were formed upon the recognition of this fact, that, in addition to the reform in the burial of the dead, we have an equally pressing need for reform in the certification of

death, and that these two things ought to be combined under the charge of the Medical Officer of Health for the city.

The statistics I had before me as regards uncertified deaths were taken from Sir Charles Cameron's pamphlet on the cremation movement. In 1885, in England and Wales, out of a total of 522,750 deaths, 26,637 cases were returned as ill-defined or not specified, while of the remaining deaths, 27,798 were certified with or without inquest by coroners, and 18,146 (about equal to the entire death-rate of Glasgow) were not certified at all. In Glasgow, prior to 1876, the average proportion of non-certified deaths was 22 per cent., and it only fell from this enormous percentage when the Friendly Societies Act made it necessary to produce a medical certificate of death of any member under ten years of age. Taking the uncertified deaths, and the necessity for a reform of registration, and keeping in view the large numbers of the dead bodies undergoing putrefactive decomposition in a degree dangerous to health, and that our sanitary and parochial authorities are responsible for 2,000 bodies being interred in pits per annum, it appeared to me that the erection of a crematorium was a duty which fell to the Health Committee of the city, and that its administration should be placed under, and, in a sense, become the headquarters of, the Medical Officer of Health. If this was done, the inquest room, or public mortuary, would form an important department of the official work.

In holding and expressing these views, I moved too fast, for it is evident that there is considerable indifference shown by the authorities regarding uncertified deaths, and the community, as a whole, has not insisted upon coroners' inquests, while our civic authorities are not leading public opinion, but are waiting to be led either by it or by us. I have also to regret that the working-classes, or their trade organisations, have not yet realised the fact that a reform in the registration of death and in the burial of their class is urgently required. The erection of a crematorium on these lines has, therefore, been rendered impracticable; but it is gratifying to know that, while those responsible for public health have done nothing to further the movement, sanitarians have combined with gentlemen interested in the decent burial of the poor to erect the necessary buildings.

In this connection, I think that it cannot be too strongly stated that cremation, while it may be esteemed the luxury of the rich, is, in reality, identified with and essential to the respectability of the

poor. As a Sanitary Section, we have no alternative but to class the dead as a not unimportant factor in connection with waste matter undergoing putrefactive fermentation in a degree dangerous to health, and that being so, we will fail in our ideal of obtaining a pure atmosphere and low death-rate if we do not speedily reduce all waste matter to its constituent elements by rapid combustion; and, particularly, does it fall to us to make this operation, as regards the bodies of our departed friends, so refined, religious, and beautiful, that cremation will receive public support, and solve the hygienic problem to which I have endeavoured to draw your attention.

XVII.—*Some Early Treatises on Technological Chemistry. Supplement.* By JOHN FERGUSON, LL.D., F.R.S.E., F.C.S., Regius Professor of Chemistry in the University of Glasgow, President of the Society.

[Read before the Society, 2nd May, 1894.]

§ 1. How difficult it is to exhaust a subject, or to make sure that nothing has been overlooked, experience has shown me once more.

In 1886 I communicated to the Society a paper describing a series of twenty-eight different books and editions, published between 1531 and 1720, which, though varying in their contents to a considerable extent, revealed an unmistakable connection with one another. For that reason these books were chosen as illustrating the state of technological chemistry, or, as may be said, the chemical processes for the accomplishing of certain practical results, used in the first half of the sixteenth century, the time when the books were first compiled, and for a couple of centuries later.

In the original paper the books were described as being rare. I have found no reason for altering this statement; for, although on the watch for the occurrence of copies of them, and especially of copies that I did not know, I have, during the past eight years, met with only two or three in catalogues, where they have been usually called scarce, and priced accordingly.

Though at the time I did not believe that I had seen all the existing variations and editions (*Proceedings*, Phil. Soc., Glasgow, 1888, Vol. XIX., p. 126, Reprint, p. 25, No. 17), I thought I had exhausted all that were accessible to me. This, however, was an error, for, by following up one of my own references, I should have found the group of editions, the consideration of which has rendered this supplementary notice necessary.

§ 2. In the original paper (*Proceedings*, Vol. XIX., 1888, p. 136, Reprint, p. 12), a Dutch translation of a German version of the receipts was described under No. 6, dated 1549. It was translated by Symon Andree, and published in a tiny volume of 60 leaves. The chief difference between the two versions consists in the German collection running on continuously, whereas in the Dutch the receipts are divided into six sections or tracts. Again, in 1581, under No. 14, an edition in Dutch was described, consisting of a set of receipts in two sections. The first of these agreed with and was a reprint of the sixth tract in the 1549 edition, while the second consisted chiefly of a set of receipts which did not correspond to anything in the 1549 edition. It appeared, therefore, that while the sixth tract had been selected for reprinting, the remaining five had, for some reason or another, been omitted.

No. 19, however, dated 1600, supplied a reprint of the missing sections I.-V. This edition was in two parts; the first being a reprint of the 1581 collection just mentioned, and the second consisting of parts I.-V. of the 1549 edition. At the time, attention was directed to this rather gratuitous transposition of the sections of the original Dutch edition. Although I did not specially refer to the matter, it seemed to me anomalous that a reprint of a book first published in 1549 should be made in 1600 along with a book published in 1581, while in 1581, when an opportunity, or even necessity, for an identical reprint occurred, this was not made; and I thought that there might be a second part of the 1581 edition as there was of the other, although I had missed it. I had no means of settling this conjecture until, on consulting the British Museum Catalogue, I found under Simon Andree what I required.

§ 3. The following, then, is an account of the 1581 reprint of the first five sections of the 1549 *Kunst Boeck*, from the Museum copy, 719. a. 38:—

1.—1581.

CONST BOECK,

: Ryeulijck wten
Alchemiftichfchen gront vergadert. Tracterende van allen grondtlijcken ghebruyckinghe der Conften.

Nutlick voor allen Wercklieden, als Muntmeefteren, Goudtwerckers, Scheyderen, Goutfmeden, Schilderen, ende allen Wercklieden werckende in Stael, Yfer, Koper, ende alle ander metalen. Item om alderhande plecken wt te doen. Om alderhande colueren te verwen. Van verguldinghe ende verfilueringhe. Ende van Werckinghe der Alchemiftiffchen dinghen. &c.

Gecolligiert ende eenfdeels getranflateert, door Symonem Andree van Aemfterdam.

Niemant en haet die konft, dan die onwetende.

Gedruckt toe Reefs, By my Derick Wylicx van Santen. Anno. 1581.

Small 8°. A—D in eights; or ff. xxx [2]. Black letter.
Collation:—Ai f [i] Title, verso blank.
Aij f ii*r* Text begins, and ends Dvj*r*., fol. xxx*r*.
Dvj*v* Die Tafel, ends Dviij*v*.
Colophon:
Gedruckt Toe Reefs, By my Derick Wijlicx van Santen. Anno. 1581.

It is divided into five Tracts:—

The first begins	Om yser hardt te maken.
and ends	Om alle Instrumenten fchoon te houdē.
	f. ii*r* to f. viij*v*.
The second begins	Om laecken fyne verlooren verwe wedder te gheven.
and ends	Vlecken van Olye wt perkement.
	f. viij*v* to f. xj*r*.
The third begins	Om garen ende lijnwaet bruyn te verwen.
and ends	Grau Garen te verwen.
	f. xj*v* to f. xvj*v*.

The fourth begins	Mercurium arbeyden ende harden datmen hem ghieten ende fmeden kan.
and ends	Een glas broock te remedieren.
	f. xvj*v* to f. xxij*r*.
The fifth begins	Om gout te scheyden wt Siluer.
and ends	Tin te maken dattet miet kraeckt.
	f. xxij*r* to f. xxx*r*.

§ 4. The following is a summary of the Dutch editions, of which I know three:—

a. The first, printed in 1549 (1551 in the Colophon), contains six tracts corresponding practically with the German of 1537 (see original paper, No. 6).

b. The second, printed in 1581, is in two parts. One part, entitled *Const Boeck*, just described, contains tracts I.-V. of Andree's 1549 edition. The other part (see original paper, No. 14), entitled *Een Schoon Tractaet*, contains tract VI. of the 1549 edition, and a number of other receipts which do not occur in the earlier versions of the collection.

c. The third, which appeared in 1600, is merely a reprint of the 1581 edition. In its arrangement, however (see title page under No. 19 of the original paper), the order is inverted, *Een Schoon Tractaet* comes first, and the *Const Boeck* last.

To complete this review, it has still to be decided whether or not there be an earlier edition of the additional receipts—either separate, or conjoined with some other work—than 1581, or whether they first appeared in that year in the volume above mentioned.

§ 5. The editions of this collection of receipts, the recent investigation of which has formed the chief reason for the present supplement, must now be considered.

In the original paper, under the following numbers and dates, viz.:—No. 10, 1573; 13, 1576; 23, 1637; 25, 1691, four editions of the French translation by Dr. Christofle Landré of the *Secrets* of Alexis were described, each of them containing in the third part the receipts of the *Kunst Boeck*, arranged in six tracts as in the Dutch version. Notwithstanding the obvious suggestion supplied by these references to examine other editions of Alexis for the receipts, I did not follow it up, chiefly from not having ready access to the various editions, and from not having made a special examination of the bibliography of that author. Since then, however, the latter difficulty has been at least partly overcome, for having recently investigated all the available editions,

I am in a position to supply this blank in the original paper. Even now, however, I am not confident that the list is complete, because I am not quite certain that I have examined all the editions. It would be out of place to go into the bibliography of Alexis' book here, both because of its extent, and because I mean to treat it in a monograph, in connection with a different branch of the subject of books on receipts and secrets, so that I must confine myself to a bare enumeration of the editions of Alexis which I know contain the *Kunst Boeck* Receipts.

§ 6. It may be necessary, however, to premise that Alexis' receipts are arranged in four parts, which, at least in the early editions, appeared separately with different dates, though they were afterwards printed together. The first part is undoubtedly, the second may be by Alexis, the third is a compilation from divers sources, though said to have been made by him. I am entirely doubtful about this, but for the present theme it is only of importance that the compilation was made at all, not that it was made by Alexis. The best evidence that it is not by him is to be found in the fact that this part differs in different versions, in the Italian and French, for example.

So far as I have observed, the *Kunst Boeck* receipts occur only in the third part of Alexis; the other parts, therefore, may be left out of account.

In the original paper, I followed a strictly chronological order, irrespective of language. This was necessary in order to trace the history of the collection in its growth and divergences. On the present occasion, however, as there are no variations to be considered, I shall deal with the successive editions in each language by themselves.

§ 7. Alexis' work was published originally in Italian. The first part was printed in 1555 or 1556, the second at Milan in 1558, the third also at Milan in 1559. I have examined this edition of the third part, and others, dated respectively 1563, 1568, 1595, 1674, but not one of them contains the *Kunst Boeck* Receipts. I am inclined to believe, therefore, that these receipts, which, in various forms, passed through so many editions in other languages, were not translated into Italian, and were never included in the Italian editions of Alexis.

§ 8. I pass, therefore, to the French translation, all the copies of which that contain the third part include, as an integral

portion of it, the *Kunst Boeck* Receipts. The *Secrets* of Alexis, translated from Italian into French, was first printed at Antwerp by Plantin in 1557. This, of course, contained only the first part in six books. The whole three parts were not printed by Plantin at Antwerp till 1559, in octavo.

2.—1559. The third part has the title: *Secrets, ov Receptes Sovvraines, bien experimentées et approvvées par Divers Avtevrs.* The different parts are not distinguished as first, second, third, but have separate titles, and this third part is not ascribed to Alexis at all. In this edition the *Kunst Boeck* Receipts are contained, ff. 41-67 verso. The only copy of this edition which I have seen is in the Bibliothèque Ste. Geneviève at Paris.

3.—1560. The Lyons edition of this year is entitled *Empirie, et Secrets dv S. Alexis* . . . and it was printed by Guillaume Rouille, in 16mo. The third part has this title: *La Troisieme Partie des Secrets ou Receptes Souueraines, experimentées & approuuées par diuers Auteurs. Continuant les liures du Seigneur Alexis Piemontoys.* It was printed, however, not by Rouille, but by Thibauld Payen, and is dated 1561. It is obvious that this part was thought not to be by Alexis. The *Kunst Boeck* Receipts are contained in this part, pp. 143-240. The copy of this edition is also in the Bibliothèque Ste. Geneviève at Paris.

4.—1561. Plantin's third edition of Alexis, Antwerp, in 8vo. Part III. is again distinctly ascribed to different authors, and Alexis' name does not appear. The *Kunst Boeck* Receipts are in Part III., ff. 35 recto to 56 recto. From a copy in my own possession.

5.—1564. Rouille, at Lyons, reprinted the edition of 1560 with the same title: *Empirie, et Secrets Dv S. Alexis* . . . The title of the third part is also a reprint, and the contents are still distinguished from those by Alexis. This is a tidy, clearly printed volume in 16mo. As in the 1560 edition, the Receipts are contained in Part III., pp. 143-240. The third part has Rouille's name on the title-page, but at the end is the colophon :—A Lyon. Par Hvgves Barbov. 1565.

6.—1564. An edition similar to those of Lyons came out at Paris *chez Hierofme de Marnef, & Guillaume Cauellat*, in 16mo. The book is paged continuously, and there are no separate title-pages. Part III. is described, however, as being by divers authors, in continuation of Alexis. The Receipts are contained pp. 760-846. This edition is in the Bibliothèque Ste. Geneviève at Paris.

7.—1573. A similar edition was again printed at Paris by Marnef and Cauellat. This was the earliest edition in French, which I quoted in the original paper. Being acquainted with it, I should have examined the other editions in French. The Receipts occur pp. 760-846. This edition is in the British Museum, 7944. a. 25.

8.—1576. A third (?) edition by Marnef and Cauellat was published in the same form. I mentioned it in the original paper under No. 13. The Receipts are contained pp. 760-846. From a copy in my own possession.

9.—1578. There was an edition of Alexis published at Lyons in this year by Estienne Michel, in 16°, but, as the contents have been to a certain extent classified, the *Kunst Boeck* Receipts have disappeared as a separate section, and have got scattered among the others. Though the Receipts, therefore, may be all present, this can hardly be reckoned as one of the editions of the *Kunst Boeck*.

10.—1579. The same may be said of the re-issue of this book in 1579 by Loys Cloquemin, in which the only differences are the title-page, and sheets a and b, which have been re-set. These editions are in the Bibliothèque St. Geneviève.

11.—1614. Printed at Rouen, by Robert de Rovves, in 16°. The Receipts occupy pp. 760-846. There is a copy in the Bibliothèque Ste. Geneviève, as also one in my own collection.

12.—1637. This is a very shabby reprint by Jean Berthelin, at Rouen, in small 8°. The Receipts are in pp. 564-631. This edition will be found in the original paper, No. 23.

13.—1642. An edition similar to that of 1637 was printed at Rouen by Martin de la Motte, if, indeed, it be not the same book with a new title-page. As the two copies are in non-lending libraries, it was out of my power to compare them. The Receipts, as before, are in pp. 564-631. The present copy I examined in the Bibliothèque Communale at Amiens.

14.—1691. Still another Rouen edition, by Jean-Baptiste Bensongne, in 8vo. This is certainly different from those of 1637 and 1642, as, after an interval of fifty years, it could hardly fail to be. The Receipts occupy pp. 602-670. It is in the British Museum, 7321. aaaa. 5.

This is the last of the French editions of Alexis with which I am at present acquainted. It is not impossible that there were other early sixteenth century issues in 16mo at Paris, and in 8vo at Rouen during the seventeenth or even eighteenth century, in the degenerate chap-book form in which some of the above-mentioned appeared.

9. The same collection of receipts makes its appearance in English in the third part of Alexis. The translation of the first three parts was made by William Warde, and the first editions of each are dated 1558, 1560, and 1562 respectively. The fourth part was by Richard Androse, and appeared in 1569. These first editions are very difficult to get together. Various reprints of the separate parts were made in subsequent years, but in the

latest editions the four parts were printed continuously and uniformly. All the editions are in small quarto, and are printed in black letter. In the title the third part is stated to have been collected by Alexis "out of diuers excellent Authours," which is going a good deal further than the French of 1560 and 1564, and is not justified by facts so far as I am aware.

The following is a list of the editions of the English translation of the *Kunstboeck* as contained in Alexis, Part III. :—

15.—1562, by Roulande Hall, for Nycholas Englande. ff. 52 recto, to 79 verso.

16.—1566, by Henry Denham, for John Wyght. ff. 50 recto, to 75 verso.

17.—1578, by Thomas Dawson, for John Wyght. ff. 50 recto, to 75 verso.

18.—1595, by Peter Short, for Thomas Wight. ff. 242 recto, to 267 verso.

19.—1615, by William Stansby, for Richard Meighen and Thomas Jones. ff. 242 (misnumbered 250) recto, to 267 verso.

§ 10. The translation, unlike the German of 1537 (original paper, No. 3), but like the Dutch of Andree or Andriessen and the French of Landré, is divided into six tracts, which are titled respectively as follow. I quote the first edition of 1562, and compare it with the Dutch rather than with the German, on account of the division into sections :—

f. 52 *recto*. Here after folowe manye | goodly receyptes, touchynge the handelynge | of dyuers metalles, all well tryed | and approued. |

This agrees with the first tract in the Dutch of 1549.

f. 57 *verso*. The | feconde Booke containyng | the maner howe to take oute quickly with water or | lye, without hurtinge any thynge, all maner of | fpottes of garments of clothe, veluet, filke, | or other, whether they be fpottes of | oyle, greafe, wyne, or what fo | euer they be. |

This agrees with the second tract in the Dutch of 1549, except a receipt to stiffen velvet, which has been omitted from the translation.

f. 60 *recto*. The | thyrde Booke, for to dye | threede, yarne, or linnen cloth, teaching howe to | make the dying colours, and alfo to dye bones | and hornes, and to make them fofte, | vnto what forme and fafhion | a man wyll. |

This agrees with the Dutch so far as it goes, but at the end certain receipts which are in the *Kunst Boeck* are omitted. These are: to dye faded silk black; to dye coifs or silk red; to dye yarn "terrat" (which was done by mordanting with alum and then

boiling with the rinds of pomegranates and oranges); to dye yarn black and grey. These extra receipts appear also in the French of 1564, but not in that of 1561, 1576, and 1614, so it would appear as if Warde followed Plantin's French edition, and not the original Dutch.

f. 64 *recto.* The | fourth Booke, teachynge | diuers wayes of gilting, fyluerynge, and di- | ynge copper, iron, and other metalles : | Likewife to forme, melt, and to make | certaine colours. |

In this book, also, there are some receipts omitted which are in the Dutch, but not in Plantin's French edition of 1561: to make moulds for casting; to make cinnabar and azure; to make goldsmith's borax.

f. 68 *recto.* The | fyfte Booke, touchynge | all feparations of gold, of filuer, of copper, and | other metalls, and how a man may try them | and to vse them profitably. Which is a | thing very gainefull for all gold- | fmithes, marchantes, and o- | ther that haue nede | of it. |

In this book there are several omissions from the *Kunst Boeck*: to give tin a golden colour; to cast twelve and nine carat gold; to give weight to gold; to separate silver from slags; to silver copper; to give copper a golden colour; to give copper a golden colour, and to make it draw, hammer, and cast like gold; a red water, which makes objects dipped in it like gold; a strong parting water (nitric acid); water of tartar; to whiten copper.

f. 73 *recto.* The | fyxte Booke, touchyng the | makynge of certayne oyles and waters and o- | ther fubftances whiche are of a mer- | ueylous uertue and ope- | ration.

The omitted receipts are these: to make gold out of mercury; brass into gold; to purify gold; to make filver from salamanders; to make crocus martis; to make æs ustum or crocus veneris; coagulation of mercury; to calcine and purify the seven planets (metals), gold, silver, copper, lead, tin, or lead, to calcine tin hard and white, iron, purification of copper, calcination of alum; and, the last receipt of all, to grade gold, or purify it to a very high degree.

So far as I am aware, the above is a complete list of the editions in English.

§ 11. In the original paper there was not included a Danish translation purporting to be from Alexis. There is a copy in the British Museum (441. b. 22 (2)), and I took note of it in connection with that author. But, though nominally by Alexis,

a more careful examination of it, which I have just made, shows that it also belongs to the set of tracts now under consideration. The following is an account of it—

20.—1648.

En liden dog konſterig Bog
Om adſkillige ſlags
Farffve oc Bleck.
Hvorledis mand ſkal farffve Træ,
Been, Jern, Tin, Glas, Byrſter, Klæde, Sil-
cke, Skind oc Ledder, ſaa om atſkillige ſlags Farffve at
berede, at ſkriffve oc male med.
Alle Skriffvere, Malere, Billed-
huggere, Indleggere, Snedickere, Beendreyc-
re, Fellberedere, Farffvere, Skomagere oc an-
dre ſom til ſaadant Lyſt haffver
til Tieniſte.
Paa Tydſke Tungemaal förſt ſammenſkreff-
ven aff den vjtberömte, velforfarne
mand
ALEXIO PEDEMONTANO.
Oc nu meenige Mand til beſte oc Tieniſte paa
vort Danſke Sprog transferêret, udſat oc til
Trycken forfærdiget.
Prentet i Kiöbenhaffn, Aar 1648.
Aff Peter Hake.
Paa Jörgen Holſtis Bogh. Bekoſtning, oc findis
hos hannem tilkiöbs.

Small 4°. Title; reverse, p. 2 and p. 3, verses to the reader. Text, pp. 4-64. Alphabetical Index, pp. [4]. Signatures G to O in fours. P. in two.

Though printed as a distinct tract, the signatures show that it is really a supplement to a tract of the same printer, place and date, entitled:

Œconomia Eller Nödvendige Beretning oc Anleding, hvorledis en gandske Huufzholding paa det nytteligste oc beste (ſaa fremt Gud allermæctigste giffver sin Velsignelse) kand anstillis.—From the German of Caspar Jugel.

§ 12. On examination, there was little difficulty in ascertaining the sources from which the tract had been taken, and the reason for assigning it to Alexis. It contains, in all, 122 receipts, brought together for the use of a variety of people who employ inks, colours, dyes. The sources are these:—

The receipts from p. 4 down to p. 38 form a translation of Alexis, Part I., Book V., with hardly any variation.

It begins on p. 4 :

I. En god blaa Farffve at berede, or, in the English version (1568), "To make perfyt asure, such as commeth from beyond the seas ;" and ends at the foot of p. 37 : 64. Bleck at giöre Linier med, hvilcke mand igien Kand udslette, naar mand hafver skrefven der effter, or, To make incke to rule paper for to write by, wherof the writinge being drie, the lines maye so be taken out, that it shall seeme ye have written without lines ; the receipt coming at the top of p. 38. Then follows : 65. At giöre Bleck behendigt oc konsteligt aff mangehaande slags Konster, Skriffvere meget nyttige at vide, which is the beginning of the translation of the *Ettliche Künste* (1563) Receipts.

The last receipt is :

122. Mange haande Farffve, at Farffve Pergament med, corresponding to Mancherley Farben Pergamen zu ferben on Ciij *verso* of *Ettliche Künste.*

This Danish translation, therefore, takes up the section on inks and colours which appear in the German *Künstbüchlin* of 1537 (original paper, No. 3), but which were omitted in the Dutch of 1549 and its reprints, and were printed separately in German in No. 8, *Ettliche Künste*, 1563 ; No. 22, *Kunstbüchlein*, 1616 ; and in English, 1596. For these, reference must be made to the original paper.

§ 13. The preceding list shows that, whatever value is to be attached to the practical instructions imparted by this collection of receipts, it was always before the public in German, Dutch, French, English, Danish, and if not in one form, then in another. The *Künstbüchlin* had a considerable circulation by itself, but it had also the fortune to be associated with the work of Alexis, and it shared in the popularity which that book undoubtedly enjoyed. Perhaps, but for that, it would have been superseded by Alexis' collection. The fact remains, however, that from the year 1531, when the little quarto volume first appeared, down to 1720, which is the latest date I can fix, it went through somewhere about fifty editions. I say "somewhere," because it is likely that there are other editions of which I have found no copies, and not even a notice.

The contents of the book must have soaked very thoroughly into the public mind by actual reading and by tradition. The

methods which the book contained would be often employed without the operator knowing where they first came from, or who first described them.

P.S.—In the original paper I have observed certain errors and omissions, which I take this opportunity of correcting:—

Vol. XIX., p. 137 (Reprint p. 12), l. 6, *for* attained, *read* attained to.
,, p. 139 (,, p. 14), l. 1, *for* dyeing, *read* dye.
,, p. 144 (,, p. 19), l. 12, *for* 80, *read* 81.
,, p. 146 (,, p. 21), l. 32, *for* use, *read* use of.
,, p. 149 (,, p. 24), l. 16), *for* 55, *read* 59.
,, p. 150 (,, p. 25), l. 6 *from bottom, after* Museum *insert* (C. 31. c).
,, p. 153 (,, p. 28), l. 24, *for* 1037, *read* 1036.

REPORTS OF SECTIONS.

SESSION 1893-94.

[Received at Meeting of Society, 3rd May, 1894.]

1. Report of the Architectural Section.

This Section held eight Meetings during the Session, at which the following papers were read :—

Monday, 13th November, 1893. — Mr. Campbell Douglas, architect, F.R.I.B.A., President of the Section, delivered his Opening Address on "Architecture as an Art."

Monday, 27th November, 1893.—Mr. Malcolm Æ. Macbean, Assoc. M. Inst. C.E., read a paper. Subject: "Town Drainage."

Monday, 11th December, 1893. — Mr. James Cairns, clerk of works, read a paper. Subject: "Impressions of Norway." (Illustrated with lime-light views.)

Monday, 22nd January, 1894.—Mr. A. Lindsay Miller, architect, read a paper. Subject: "Linlithgow, its Palace and the Church of St. Michael." (Illustrated by lime-light views.)

Monday, 5th February, 1894.—Mr. R. J. Bennett, decorator, read a paper. Subject: "The Building Exchanges of America and Impressions of the Chicago Exhibition." (Illustrated by lime-light views.)

Monday, 19th February, 1894.—Mr. George W. Barras, writer, read a paper. Subject: "The Glasgow Building Regulations Act of 1892."

Monday, 5th March, 1894.—Mr. P. Macgregor Chalmers, F.S.A.Scot., architect, read a paper. Subject: "Scottish Ecclesiastical Architecture." (Illustrated by lime-light views.)

Monday, 19th March, 1894.—Mr. J. Hyppolyte Blanc, A.R.S.A., architect, Edinburgh, read a paper. Subject: "A few Notes on the Collegiate Churches of Scotland."

The thanks of the Section are due to those gentlemen for their kindness. During the Session 19 Associates joined the Section.

At the Annual Business Meeting held on the evening of Monday, 19th March, 1894, the gentlemen named on p. 261 were elected to office for next Session.

A. LINDSAY MILLER, Architect,
Hon. Secretary,
122 Wellington Street.

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2. REPORT OF THE GEOGRAPHICAL AND ETHNOLOGICAL SECTION.

During the Session two papers were read before the Society as contributions from the Section :—

(1.) "Above the Snow-Line in Scotland," by Mr. Gilbert Thomson, C.E., on 10th January, 1894.

(2.) "Nyasaland," by Captain M'Auslan, on 4th April, 1894.

In addition to these, four meetings have been held under the joint arrangement with the Royal Scottish Geographical Society, at which the following papers were read :—

(1.) "My Experiences in Tibet," by Miss Annie Taylor, on 22nd December, 1893.

(2.) "British Sea Fisheries and Fishing Areas," by Mr. W. L. Calderwood, F.R.S.E., on 8th January, 1894.

(3.) "The Southern Regions of Chili," by Mrs. Grove, on 9th November, 1893.

(4.) "The Mountain Systems of Central Asia," by Mr. E. Delmar Morgan, on 26th April, 1894.

G. A. TURNER, M.D.,
Secretary.

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3. BIOLOGICAL SECTION

4. CHEMICAL SECTION.

Both of these Sections are for the present suspended by vote of Council, 26th November, 1890.

5. Report of Economic Science Section.

Six Meetings have been held in connection with the Section during the Session 1893-94:—

27th November, 1893.—Presidential Address by Dr. Wm. Smart—Subject: "A Living Wage." At this Meeting, and at several of those that followed, Members of the Trades Council were present by invitation, and some of them took part in the discussion of industrial questions.

29th November, 1893.—Paper by Mr. Alexander Macindoe, C.A., on "The Report by Lord Herschell's Commission on Indian Currency." (Read before the Society.)

30th January, 1894.—Meeting for the discussion of "The Sliding Scale as a means of determining Miners' Wages." The discussion was based on papers on the subject contributed by the President to the *Glasgow Herald* on January 8th, 11th, and 17th, and was opened by Mr. George L. Mitchell, coalmaster.

7th March, 1894.—Paper on "Recent Monetary History and Recent Monometallist Arguments," by Mr. Geo. Handasyde Dick. (Read before the Society.)

22nd March, 1894.—Meeting of Section for discussion of the "Monetary Question," on the basis of Mr. Dick's paper of March 7th.

27th March, 1894.—Paper by Mr. John Inglis, shipbuilder, on "The Apprentice Question."

Walter W. Blackie,
Hon. Secy. of Section.

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6. Report of Mathematical and Physical Section.

I really do not know what report to make regarding the above. I suggested last November that it might be as well suspended, as far as any Meetings of the Section are concerned. Of course there are no Associates, and hence no need to have Meetings of the Section. Something like last year's report is the only report I could give. But I shall call a Meeting of Office-Bearers in October to consult them on what future action to take.

Magnus Maclean,
Hon. Secretary.

7. Report of Sanitary and Social Economy Section.

A Meeting of the Section was held on 26th October, 1893, at which the Office-Bearers for the year were elected. [Their names appear on p. 261.]

The President (Mr. James Chalmers, I.A.) delivered his Inaugural Address on 13th December last, the subject being the "Solution of some important Sanitary Problems."

Efforts were made to have one or two interesting papers read during the course of the Session, but, unfortunately, pressure of work on the part of the intended Lecturers prevented this being carried out.

W. R. M. Church, C.A.,
75 St. George's Place,
Hon. Secy.

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8. Report of the Philological Section.

I have to report that, at the beginning of the Session, Dr. David Ross, M.A., B.Sc., was elected President, in room of Rev. Professor Robertson, who had ceased to be a Member of the Society. There were no other changes among the Members of Council.

No Sectional Meetings have been held, but two Members—Dr. Ross and M. Rey—contributed papers, which were read before the Society.

I have no monies to transmit to the Treasurer, and no expenses against the Society.

James Colville,
Hon. Secy. and Treasurer.

MINUTES OF SESSION.

1st November, 1893.

The Philosophical Society of Glasgow held its First Meeting for Session 1893-94, in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 1st November, 1893, at Eight o'clock—Professor John Ferguson, LL.D., President, in the Chair.

1. The Minutes of Meeting held on 3rd May, 1893, were read and approved of, and signed by the Chairman.

2. The President then proceeded to deliver the Opening Address, which dealt largely with the work done by the Society during its past career, and that done by scientific societies generally. At the close of the address, the President, on the motion of Mr. Alexander Scott, was awarded a very hearty vote of thanks.

3. Mr. Golan E. Hoole, Lecturer on Vocal Physiology, Athenæum School of Music, read a paper on "Some of the Physical Causes which influence the Pitch and Quality of various Classes of Voice." After some remarks from Mr. Campbell Douglas, Dr. William Wallace, and Mr. Knight, the best thanks of the Meeting were awarded to Mr. Hoole for his paper.

4. Mr. Sam Mavor and Mr. James Chalmers were appointed Auditors to examine the Treasurer's Accounts for the year 1892-93.

5. The Chairman announced that all the new Candidates for admission into the Society—as follow—had been elected :—

1. Mr. Louis H. Cooke, Assoc. Royal School of Mines, Lecturer on Geology and Mining, Glasgow and West of Scotland Technical College. Recommended by Professor A. Humboldt Sexton, Dr. Henry Dyer, and Professor G. G. Henderson.
2. Mr. James Hendrick, B.Sc., F.C.S., "Young" Laboratory of Technical Chemistry, 60 John Street. Recommended by Professor E. J. Mills, Professor G. G. Henderson, and Mr. John Mayer.
3. Mr. William Henry Watkinson, Whit. Sch., Professor of Steam, Steam Engines, &c., Glasgow and West of Scotland Technical College, 24 Albion Crescent, Dowanhill. Recommended by Dr. Henry Dyer, Professor A. Humboldt Sexton, and Professor James Blyth.

4. Mr. A. MACLEOD, Electrical Engineer and Contractor, 3 Dundas Street. Recommended by Mr. John Turnbull, jun., Mr. Andrew Meikle, and Mr. John Mayer.

5. Mr. JOHN HENDERSON, Letterpress Printer, 38 Berkeley Street, Glasgow. Recommended by Mr. Walter W. Blackie, Dr. W. G. Blackie, and Mr. John Mann.

15th November, 1893.

The Annual General Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 15th November, 1893, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the First Ordinary General Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 1st November, were admitted to the Membership of the Society :—

1. Mr. LOUIS H. COOKE, Assoc. Royal School of Mines, Lecturer on Geology and Mining, Glasgow and West of Scotland Technical College.
2. Mr. JAMES HENDRICK, B.Sc., F.C.S., "Young" Laboratory of Technical Chemistry, 60 John Street.
3. Mr. WILLIAM HENRY WATKINSON, Whit. Sch., Professor of Steam, Steam Engines, &c., Glasgow and West of Scotland Technical College, 24 Albion Crescent, Dowanhill.
4. Mr. A. MACLEOD, Electrical Engineer and Contractor, 3 Dundas Street.
5. Mr. JOHN HENDERSON, Letterpress Printer, 38 Berkeley Street, Glasgow.

3. The Annual Report by the Council on the State of the Society, having been printed in the Billet convening the Meeting, was held as read. Its adoption was moved from the Chair, and unanimously agreed to. The Report is subjoined :—

REPORT OF COUNCIL FOR SESSION 1892-93.

I. *Meetings.*—The Society's work during Session 1892-93 began with a meeting in the Physiology Class-Room of the University, on 2nd November, 1892, when Dr. M'Kendrick, President, gave the opening address, his subject being "Recent Notions about the Action of a Nerve." All the other meetings, twelve in number, were held in the Society's Rooms, the closing one on 3rd May, 1893. Including the opening address, and a

lecture by Mr. F. C. Selous, on "Twenty Years of Travel in South-Central Africa," twenty-three communications were made to the Society's meetings. There were likewise four meetings held under the joint-arrangement with the Royal Scottish Geographical Society, at each of which an illustrated lecture was given by some well-known traveller.

II. *Membership.*—At the beginning of the Session there were 628 Ordinary Members on the Roll. In course of the Session, 43 candidates were elected to the Membership, and from the "Suspense List" 1 Member was reinstated, making 672. Of these, 21 have resigned, 8 have died, 2 have left Glasgow, and their names have been placed on the "Suspense List," and 1 has been struck off the Roll for non-payment of subscriptions, so that at the beginning of 1893-94 there were 640 Members, being an increase of 12. Of the new Members admitted during the Session, 7 qualified themselves as Life Members. There are now 127 Members of that class. In the List of Honorary Members, the number of whom is limited to 20, there are three vacancies, so that the Roll now includes 17 Honorary Members, 5 being Continental, 4 American or Colonial, and 8 British. The number of Corresponding Members remains at 10, as it was last year. The Membership of the Society, then, is as follows :—Honorary Members, 17; Corresponding Members, 10; Ordinary Members (Annual and Life), 640; or a total of 667.

III. *Deceased Members.*—The Council regret the loss, during the year, of three well-known members of the Society—Mr. W. R. W. Smith, Sir Michael Connal, and Mr. John Jex Long—of whom biographical notices will be found in the new volume of the *Proceedings.* The same volume also contains obituary notices of Dr. Robert Grant, F.R.S., Regius Professor of Astronomy in the University of Glasgow, by Professor William Jack, LL.D., and of Dr. James Thomson, C.E., F.R.S., Professor of Civil Engineering and Mechanics in the same university, by Dr. J. T. Bottomley, F.R.S. The Society has recently lost one of its corresponding members in the Rev. Dr. Crosskey of Birmingham, who was formerly an active and useful member of the Society, and at one time its Honorary Librarian.

IV. *Sections.*—As in former years, the *Architectural Section* was exceedingly active during its Session, which terminated in the middle of March. Eight meetings of the Section were held, at which papers were read having much interest for ordinary as well as professional members of the Society. Only one paper was offered by the Council of this Section for publication in the *Proceedings.* It appears as a very comprehensive abstract. No separate meetings of any of the other Sections were held for the reading of papers, but a number of important communications were provided by or through the *Geographical, Economic Science,* and *Mathematical and Physical Sections.*

V. *Proceedings, Volume XXIV.*—In this Volume there are given twenty communications, four of which—biographical notices of deceased members—were not read at Society meetings, but prepared specially for publication in the *Proceedings.* A considerable number of illustrations are given in the text; and there are also six separate plates.

VI. *Finance.*—The Treasurer's Statement opens with a balance of £250 7s. 7½d., and closes with a balance of £271 12s. 6½d., being an increase of funds during the year of £21 4s. 11d. It is believed that practically all current indebtedness of the Society, up to the closing date of the Session, has been paid.

By order and on behalf of the Council.

(Signed) JOHN MAYER,
Secretary.

4. The Treasurer's audited Statement of the Funds of the Society, which had also been printed in the Billet, was next submitted by the Chairman, and its adoption was unanimously approved of. The Abstract of Treasurer's Account of the Graham Medal and Lecture Fund, and that of the Science Lectures Association Fund, were also submitted and approved of. [These Statements, signed by the Auditors, were laid on the table, and are given on pp. 244-247.]

5. Mr. John Robertson, on behalf of the Library Committee submitted the Report on the State of the Library. Its adoption was agreed to, and, on the motion of Mr. Robertson, the thanks of the Society were awarded to the donors of Books to the Library during the year. The Report was as follows :—

REPORT OF THE LIBRARY COMMITTEE.

During the past Session, 13 volumes, 19 parts of works, and 10 pamphlets, were presented to the Library.

The Society's *Proceedings* were forwarded to 168 societies and public departments ; and 102 volumes and 141 parts of volumes were returned in exchange.

The periodicals received at the library number 99; of which 71 were bought and 28 presented. These form altogether 127 volumes.

During the year there were added to the Library 351 volumes, 183 parts of works, and 10 pamphlets. It is estimated that, at present, the number of volumes in the possession of the Society amounts to 11,641 ; and it has again become necessary to consider in what manner additional accommodation can be provided for the books.

The Committee have pleasure in reporting a very considerable increase in the number of readers during the past Session—706 volumes having been issued to 515 members.

In Volume XXIV. of the *Proceedings*, pp. 281-293, there will be found a list of the additions to the Library by purchase, up to June, 1893; the titles of the books presented, with the names of the donors, the names of the societies and public departments with which exchanges are effected, and a list of the periodicals received at the Library.

JOHN ROBERTSON, LIBRARIAN.
Convener.

Dr. ABSTRACT OF HONORARY TREASURER'S

AND COMPARISON WITH

			1892-93.	*1891-92.*
To BALANCE in Bank, less due Treasurer, from last year, .			£250 7 7½	*£257 5 1*
,, SUBSCRIPTIONS to 31st October, 1893—				
43 Entry-moneys of 1891-92 at 21s., .		£45 3 0		*19 19 0*
Annual Dues at 21s.—				
Arrears, ...	£3 3 0			
For 1892-93, 456 Ordinary Members, . . .	478 16 0			
,, ,, 36 New Members,	37 16 0			
		519 15 0		*526 1 0*
Life Subscriptions at £10 10s.—				
2 Old Members, . . .	£21 0 0			
7 New Members, . . .	73 10 0			
		94 10 0		
			659 8 0	*63 0 0*
,, GENERAL RECEIPTS—				
Bank Interest, ...		£8 0 2		*5 6 8*
Proceedings and Catalogues sold, . . .		0 8 10½		*5 2 4*
			8 9 0½	
,, ARCHITECTURAL SECTION—				
62 Associates' fees for 1892-93, at 5s., ...			15 10 0	*18 10 0*
,, ECONOMIC SCIENCE SECTION—				
1 Associate's fee for 1890-91, at 5s.,		£0 5 0		
3 Associates' fees for 1891-92, ,,		0 15 0		
24 ,, ,, ,, 1892-93, ,,		6 0 0		
			7 0 0	*6 5 0*
,, GEOGRAPHICAL AND ETHNOLOGICAL SECTION—				
2 Associates' fees for 1889-90, at 5s.,		£0 10 0		
2 ,, ,, ,, 1890-91, ,,		0 10 0		
14 ,, ,, ,, 1891-92, ,,		3 10 0		
15 ,, ,, ,, 1892-93, ,,		3 15 0		
			8 5 0	*0 0 0*
,, PHILOLOGICAL SECTION—				
Associates' fees, ...			0 0 0	*0 15 0*
			£948 19 8	*£902 4 1*

Memo. by Treasurer.—The Amount invested by the Society in the Bath Street Joint Buildings up to 31st October, 1893, is, as in last Account, . £3,547 8 1½
whereof, Paid from Society's Funds, ... £2,047 8 1½
Do. Society's half of £3,000 Bond, . 1,500 0 0
£3,547 8 1½

J. M.

ACCOUNT—SESSION 1892-93, **Cr.**

SESSION 1891-92.

		1892-93.	*1891-92.*
By General Expenditure to 31st October, 1893—			
Salary to Secretary,	£75 0 0		*£75 0 0*
Allowance for Treasurer's Clerks,	15 0 0		*15 0 0*
		£90 0 0	
New Books & Periodicals, British & Foreign,	£145 15 3½		*124 15 3½*
Bookbinding,	44 11 9		*0 17 3*
Printing Circulars, *Proceedings*, &c.,	158 0 0		*174 6 9*
Printing General Index to Vols. I. to XX. of "*Proceedings*,"	0 0 0		*28 16 6*
Lithographs, Woodcuts, &c., for *Proceedings*, &c.,	15 15 6		*13 14 6*
Postage and delivery of Circulars, Letters, &c.,	34 18 5		*31 14 3*
Stationery, &c.,	12 1 3		*1 17 3*
		411 2 2½	
Fire Insurance on Library for £5,400,	£6 1 3		*6 1 3*
Postages, &c., per Secretary, £2 6s. 10d.; per Treasurer, £2 19s. 9½d., & Sundries, £1 1s.,	6 7 7½		*4 13 3½*
		12 8 10½	
,, Joint Expenses of Rooms—Society's half of £326 5s. 6d., being Interest on Bond, Insurance, Taxes, Cleaning, Repairs, Lighting, and Heating; Salaries of Curator and Assistant, less half of £60 7s. 6d., Revenue from Letting,		132 19 0	*141 18 6½*
,, Lecture Expenses—			
Scottish Geographical Society, Rent for four Joint Lectures,	£4 10 0		*6 5 0*
Advertising, Reporting, and Sundries,	5 8 6		*7 2 6*
		9 18 6	
,, Subscriptions to Societies—			
Ray Society, 1892,	£1 1 0		
Palæontographical Society, 1892,	1 1 0		
		2 2 0	*2 2 0*
,, Architectural Section— Expenses per Treasurer of Section,		11 7 6	*8 19 4*
,, Economic Science Section— Expenses per Treasurer and Secretary of Section,		0 19 9½	*6 7 0*
,, Geographical and Ethnological Section—			
Expenses per Treasurer of Section, 1891-92, £1 18s. 9d.; 1892-93, £2 8s. 6d.,	£4 7 3		*0 0 0*
Printing Account,	1 19 6		*2 3 3*
		6 6 9	
,, Philological Section— Expenses per Treasurer of Section,		0 0 0	*0 0 0*
,, Sanitary and Social Economy Section— Expenses per Treasurer of Section,		0 2 6	*0 2 6*
,, Balances, viz.:—			
In Clydesdale Bank,	£285 0 0		
Less, due to Treasurer,	13 7 5½	271 12 6½	*250 7 7½*
		£948 19 8	*£902 4 1*

Glasgow, *8th November, 1893.*—We, the Auditors appointed by the Society to examine the Treasurer's Accounts for the year 1892-93, have examined the same, of which the above is an Abstract, and have found them correct, the Balances being—in Clydesdale Bank Two Hundred and Eighty-five Pounds, and due to Treasurer Thirteen Pounds Seven Shillings and Fivepence-halfpenny.

(Signed) JAMES CHALMERS.

JNO. MANN, C.A., *Honorary Treasurer.* SAM. MAVOR.

GRAHAM MEDAL AND LECTURE FUND.

Dr. ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1892-93. Cr.

Dr.			Cr.		
Capital at 1st November, 1892—			**Expenditure—**		
Glasgow and South-Western Railway Co. 4 % Preference Stock in name of the Philosophical Society, in Trust,	£250 0 0		Completion of Book Award, mentioned in last Account,		£2 7 6
Value of Die at H.M. Mint,	18 18 0		**Capital at 31st October, 1893—**		
		£268 18 0	Investment, *per contra*,	£250 0 0	
Cash in Bank,		26 1 5	Die,	18 18 0	
Revenue—					268 18 0
Dividend, April, 1893, less Tax,	£4 17 6		**Balance, being Revenue—**		
,, Oct. ,, ,,	4 17 3		In Bank, on Deposit Receipt,		33 18 5
Interest from Bank,	0 9 9				
		10 4 6			
		£305 3 11			£305 3 11

Glasgow, 8th November, 1893.—Examined and found correct.

(Signed) JAMES CHALMERS.
SAM. MAVOR.

JNO. MANN, C.A., *Treasurer*.

THE SCIENCE LECTURES ASSOCIATION FUND.

Dr. ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1892-93. Cr.

Dr.

CAPITAL AT 1ST NOVEMBER, 1892—		
£200 Caledonian Railway Company 4% Preference Stock, No. 1, in name of the Philosophical Society, in Trust, cost - - - - - - -	£244 4 8	
On Deposit Receipt, - - - -	8 5 4	
		£252 10 0
Cash in Bank (Revenue), - - - - - -		24 10 2
REVENUE—		
Dividend, April, 1893, less Tax, - -	£3 18 0	
,, Oct., ,, ,, - -	3 17 9	
Interest from Bank, - - - -	0 11 5	
		8 7 2
		£285 7 4

Cr.

CAPITAL AT 31ST OCTOBER, 1893—		
Investment, *per contra*, - •	£244 4 8	
In Bank on Deposit Receipt, -	8 5 4	
		£252 10 0
BALANCE, BEING REVENUE—		
In Bank, on Deposit Receipt, - - - - -		32 17 4
		£285 7 4

GLASGOW, 8th November, 1893.—Examined and found correct.

(Signed) JAMES CHALMERS.
SAM. MAVOR.

JNO. MANN, C.A., *Treasurer*.

6. The Society then proceeded to the election of Office-Bearers:—

(1) On the recommendation of the Council, and on the motion of the President, Dr. Joseph Coats was elected to succeed Professor Blyth, the retiring Vice-President.

(2) On the motion of the Chairman, Messrs. Mann, Robertson, and Mayer were re-elected Treasurer, Librarian, and Secretary, respectively.

(3) The following gentlemen were elected members of Council:—Ex-Bailie Hugh Wallace; Professor Barr, C.E., D.Sc.; Mr. H. A. Mavor, M.I.E.E.; Mr. Alexander Somerville, B.Sc., F.L.S., in succession to Mr. Walter W. Blackie, Mr. John G. Kerr, Dr. Joseph Coats, and Mr. C. A. Fawsitt, whose term of office had expired.

(4) On the motion of the Secretary (for Dr. Turner), the Office-Bearers of the Geographical and Ethnological Section were elected, in accordance with Resolution of Society of 11th April, 1883. There were also elected the Office-Bearers of the Sanitary and Social Economy Section, on the motion of the Secretary (for Mr. Church); Mathematical and Physical Section, on the motion of Mr. Magnus Maclean; and of the Economic Science Section, on the motion of Mr. W. W. Blackie—according to Resolution of Society of 18th November, 1885, and 2nd February, 1887; and, on the motion of the Secretary (for Dr. Colville), the List of Office-Bearers of the Philological Section was agreed to.

7. On the motion of the President, the thanks of the Society were awarded to the retiring Vice-President and Members of Council. Professor Blyth briefly acknowledged the vote of thanks.

8. Professor Henry Dyer, C.E., D.Sc., Life Governor of the Technical College, read a Paper on "Technical Education in Glasgow and West of Scotland: A Retrospect and a Prospect." It was followed by a discussion, in which the speakers were Dr. M'Kendrick, Mr. James Chalmers, Professor Sexton, and Mr. J. G. Kerr. Dr. Dyer made a brief reply, and, on the motion of the President, he was accorded a hearty vote of thanks for his paper.

9. The Chairman announced that all the new Candidates for admission into the Society—five in number—had been elected, namely:—

1. Walter M. Galbraith, 7 Holyrood Crescent. Recommended by Mr. Alexander Scott, Mr. William Lang, and Dr. J. T. Bottomley.

2. William Arnot, Electrical Engineer, City Chambers, Glasgow. Recommended by Lord Provost Bell, Lord Kelvin, and Dr. Bottomley.

3. ALEXANDER V. LOTHIAN, Lecturer on Mathematics and Physics, E.C. Training College, 7 Huntly Terrace, Kelvinside. Recommended by Dr. Henry Dyer, Mr. Magnus, and Mr. John G. Kerr.

4. WM. JAS. WOOD, Collector of Rates, 38 Cochrane Street. Recommended by Mr. Jas. R. Motion, Mr. John Mann, and Mr. John Mann, jun.

5. G. W. ALEXANDER, M.A., Clerk, Glasgow School Board, 129 Bath Street. Recommended by Dr. Henry Dyer, C.E., Sir John Neilson Cuthbertson, and Mr. J. H. Kerr.

29th November, 1893.

The Second Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 29th November, 1893, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Annual General Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 15th November, were admitted to the Membership of the Society:—

1. Mr. WALTER M. GALBRAITH, 7 Holyrood Crescent.
2. Mr. WILLIAM ARNOT, Electrical Engineer, City Chambers, Glasgow.
3. Mr. ALEXANDER V. LOTHIAN, Lecturer on Mathematics and Physics, E.C. Training College, 7 Huntly Terrace, Kelvinside.
4. Mr. WM. JAS. WOOD, Collector of Rates, 38 Cochrane Street.
5. Mr. G. W. ALEXANDER, M.A., Clerk, Glasgow School Board, 129 Bath Street.

3. On the motion of the President, Dr. William Smart, M.A., President of the Economic Science Section, now took the Chair, and Mr. Alexander Macindoe, M.A., C.A., read a paper on "The Report by Lord Herschell's Commission on Indian Currency." *(This was a communication from the Economic Science Section.)* A discussion ensued, in which the speakers were Mr. G. Handasyde Dick, Mr. T. N. Whitelaw, Mr. T. S. Cree, and Mr. George Younger. The author made a brief reply, and was awarded a hearty vote of thanks for his paper.

4. The Chairman announced that all the new Candidates for admission into the Society had been elected, namely :—

As a Corresponding Member.

1. William Milne, M.A., B.Sc., F.R.S.E. (formerly of the High School of Glasgow), Inspector of Schools, Education Department, Cape Town, South Africa. Recommended unanimously by the Council.

As Ordinary Members.

2. Robert M'Kechnie, Calico Printer, 23 Royal Exchange Square. Recommended by Mr. Charles S. Moir, Mr. Matt. P. Fraser, and Dr. John Clark.
3. Alexander Henderson, Governor, Barnhill Poorhouse, Springburn. Recommended by Mr. James R. Motion, Bailie Parnie, and Mr. W. Forrest Salmon.
4. Dr. Donald J. Macintosh, Western Infirmary. Recommended by Dr. J. B. Russell, Mr. John James Burnet, and Mr. John Mann, jun.
5. A. J. Gunion Barclay, M.A., F.R.S.E., High School of Glasgow. Recommended by Dr. Henry Dyer, Professor James Blyth, and Mr. William Reid.
6. Robert Wilson, Treasurer, Glasgow Water Trust, City Chambers. Recommended by Lord Provost Bell, Mr. John Mann, and Mr. John Mayer.
7. Robert Lamond, Secretary, Monetary Reform Association, 8 Marchmont Terrace, Kelvinside. Recommended by Mr. G. Handasyde Dick, Mr. F. N. Sloane, and Mr. John Mann.
8. Joseph Patrick, M.A., C.A., 203 West George Street. Recommended by Mr. John Mann, Mr. John Mann, jun., and Mr. F. N. Sloane.

13th December, 1893.

The Third Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 13th December, 1893, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Second Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 29th November, were admitted to the Membership of the Society :—

1. Robert M'Kechnie, Calico Printer, 23 Royal Exchange Square.
2. Alexander Henderson, Governor, Barnhill Poorhouse, Springburn.
3. Dr. Donald J. Macintosh, Western Infirmary.

4. A. J. Gunion Barclay, M.A., F.R.S.E., High School of Glasgow.
5. Robert Wilson, Treasurer, Glasgow Water Trust, City Chambers.
6. Robert Lamond, Secretary, Monetary Reform Association, 8 Marchmont Terrace, Kelvinside.
7. Joseph Patrick, M.A., C.A., 203 West George Street.

3. Mr. James Chalmers, I.A., delivered his Inaugural Address as President of the Sanitary and Social Economy Section, in which he dealt with "The Solution of some important Sanitary Problems." On the motion of Dr. J. B. Russell, seconded by Mr. W. P. Buchan, a vote of thanks was passed to Mr. Chalmers for his address.

4. Professor Ferguson, LL.D., F.R.S.E., President, read a short paper on "The First Edition of the Chemical Works of Democritus and Synesius." He was awarded the thanks of the Society for his paper, on the motion of Dr. Turner.

5. Mr. John Dougan, Whit. Sch., Consulting Engineer, read a paper on "The 'Paristagan' System of Building with Concrete." After a few remarks by Mr. Chalmers and Mr. M'Ara, the author was thanked for his communication.

6. The Chairman announced that the new Candidates for admission into the Society had been elected, namely:—

1. William Martin, Marine Insurance Broker, 4 North Court, Royal Exchange Square. Recommended by Mr. Patrick Falconer, Mr. Robert Mitchell, and Mr. Archibald Watson.
2. Mr. John Munn Ross, C.A., 139 St. Vincent Street. Recommended by Mr. John Mann, Mr. T. A. Craig, and Mr. John Mann, jun.

10th January, 1894.

The Fourth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 10th January, 1894, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Third Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 13th December, were admitted to the Membership of the Society:—

1. Mr. WILLIAM MARTIN, Marine Insurance Broker, 4 North Court, Royal Exchange Square.
2. Mr. JOHN MUNN ROSS, C.A., 139 St. Vincent Street.

3. Mr. Gilbert Thomson, M.A., C.E., Member of the Scottish Mountaineering Club, read a paper entitled "Above the Snow-Line in Scotland," which dealt with Scottish Mountain Scenery, more especially in winter, and was extensively illustrated by lime-light views photographed by Members of the Mountaineering Club. The author was heartily thanked for his paper and the lantern illustrations.

4. Mr. Walter Laidlaw gave a short description of the "Brunsviga" Calculating Machine, of which views were shown on the screen, and subsequently the Machine was shown in practical use in the Council Room. Mr. Laidlaw was awarded the thanks of the Society.

5. The Chairman announced that the new Candidates for admission into the Society had been elected, namely:—

1. ROBERT PARK, M.D., 24A Robertson Street. Recommended by Professor Ferguson, Dr. J. B. Russell, and Mr. John Mayer.
2. Mr. DAVID TULLIS, Leather Merchant, St. Ann's Leather Works, Bridgeton. Recommended by Sir John Neilson Cuthbertson, Mr. William MacIntyre, and Mr. Robert H. Robertson.
3. Councillor DON. HAMILTON, Registrar of Births, &c., Brandon, Uddingston. Recommended by Lord Provost Bell, Deacon-Convener M'Lennan, and Sir J. D. Marwick.
4. Mr. JOHN LAUDER, House Agent, 87 Union Street. Recommended by Mr. Gilbert Thomson, Mr. Alexander Brown, and Mr. John Mayer.
5. Mr. GEORGE MURDOCH, Stockbroker, 40 St. Vincent Place. Recommended by Mr. Charles S. Moir, Provost Kirkwood, Govan, and Mr. Joseph F. Newlands.

24th January, 1894.

The Fifth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 24th January, 1894, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Fourth Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 10th January, were admitted to the Membership of the Society:—

1. Robert Park, M.D., 24a Robertson Street.
2. Mr. David Tullis, Leather Merchant, St. Ann's Leather Works, Bridgeton.
3. Councillor Don. Hamilton, Registrar of Births, &c., Brandon, Uddingston.
4. Mr. John Lauder, House Agent, 87 Union Street.
5. Mr. George Murdoch, Stockbroker, 40 St. Vincent Place.

3. Dr. David Ross, M.A., B.Sc., Rector, E.C. Training College, read a paper entitled "Some Notes on the Dialect of Orkney and Shetland." *(A Communication from the Philological Section.)* After a few remarks from Mr. John D. Campbell, Dr. Ross made a brief reply, and was awarded the best thanks of the Society.

4. Mr. D. Bell, F.G.S., made a communication to the Society on "Evidences of the Glacial Period in the West of Scotland." Some remarks were made on the subject of the paper by Dr. Ross, Mr. James Chalmers, Mr. Campbell Douglas, and Mr. J. C. Christie, F.G.S. (a visitor); and Mr. Bell was cordially thanked for his paper, which was illustrated by Rock Specimens, Diagrams, and Maps.

5. The Chairman announced that the new Candidates for admission into the Society had been elected, namely:—

1. Mr. Malcolm Campbell, Fruit Merchant, 18 Gordon Street. Recommended by Sir James King, Bart., Bailie Parnie, and Councillor Alexander Sinclair.
2. Mr. Thomas Campbell, Ironfounder, Maryhill Ironworks. Recommended by Bailie Chisholm, Mr. Jas. D. Borthwick, and Mr. Robert Goodwin.
3. Mr. Francis Teague, M.I.E.E., Electrical Engineer, Electric Lighting Station, Coatbridge. Recommended by Mr. A. Macleod, Mr. William Arnot, and Mr. John Mayer.

7th February, 1894.

The Sixth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 7th February, 1894, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Fifth Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 24th January, were admitted to the Membership of the Society:—

1. Mr. MALCOLM CAMPBELL, Fruit Merchant, 18 Gordon Street.
2. Mr. THOMAS CAMPBELL, Ironfounder, Maryhill Ironworks.
3. Mr. FRANCIS TEAGUE, M.I.E.E., Electrical Engineer, Electric Lighting Station, Coatbridge.

3. On the motion of Mr. Walter W. Blackie, seconded by Mr. George Younger, Mr. Robert Lamond was elected to fill a vacancy in the Council of the Economic Science Section.

4. Mr. T. L. Patterson, F.I.C., F.C.S., Greenock, read a paper on "Sorghum Sugar Experiments in the United States," which was illustrated by specimens of *Sorghum saccharatum*, or Sugar-grass, and Sugar made from it; also Sugar Cane, &c. After some remarks by Mr. George Younger and the President, Mr. Patterson was awarded the thanks of the Society for his paper.

5. The Chairman announced that the new Candidate for admission into the Society had been elected, namely:—

Professor T. RHYMER MARSHALL, Chemical Department, St. Mungo's College, Glasgow. Recommended by Professors A. Humboldt Sexton, James Hendrick, and G. G. Henderson.

21st February, 1894.

The Seventh Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 21st February, 1894, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Sixth Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Professor T. Rhymer Marshall, Chemical Department, St. Mungo's College, elected on 7th February, was admitted to the Membership of the Society.

3. Mr. Stephen Adam read a paper on "The Art of Glass Staining: Mediæval and Modern Methods." After some remarks by Professor Marshall, the author was awarded the thanks of the Society.

4. A short supplementary paper was read by the Secretary, on "The Manufacture of Cathedral, Venetian, Muranese, and Rippled Plate Glass in Glasgow," for which he was awarded the thanks of the Society.

5. Mr. J. H. Cooke, Lecturer on Mining, Glasgow and West of Scotland Technical College, exhibited a Safety Lamp designed for Gas Testing, the invention of Mr. A. H. Stokes, H.M. Inspector of Mines. He also described the Lamp, and showed some experiments with it. A vote of thanks, on the motion of the President, was passed to Mr. Cooke.

6. The Chairman announced that the new Candidates for admission into the Society had been elected, namely:—

1. Mr. Alexander Macindoe, C.A., 32 Westbourne Gardens. Recommended by Dr. J. G. M'Kendrick, F.R.S., Mr. Joseph Patrick, and Mr. W. R. M. Church.
2. Mr. John A. Leslie, jun., Metal Merchant, 48 Cadogan Street. Recommended by William Lang, Professor Ferguson, and Mr. John Mayer.

7th March, 1894.

The Eighth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 7th March, 1894, at Eight o'clock—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Seventh Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. The following gentlemen, elected on 21st February, were admitted to the Membership of the Society:—

1. Mr. Alexander Macindoe, C.A., 32 Westbourne Gardens.
2. Mr. John A. Leslie, Metal Merchant, 48 Cadogan Street.

3. In consideration of the fact that the Meeting was largely one of the Economic Science Section, Professor Ferguson resigned the Chair in favour of Dr. William Smart, President of the Section.

4. Mr. George Handasyde Dick read a paper entitled "On Recent Monetary History and Recent Monometallist Arguments." A discussion followed, in which the speakers were Messrs. Wm. Douglas, John Pirie, A. G. Graham, Robert Ewen, Alex. Macindoe, and R. M. Downie. Mr. Dick made a brief reply, and was awarded a hearty vote of thanks for his paper.

5. The Chairman announced that Mr. William D. Sawers, Assoc.I.C., Analytical Chemist, 7 Buckingham Street, Hillhead, recommended by Mr. John S. MacArthur, Dr. E. J. Mills, F.R.S., and Mr. James Hendrick, had been elected a Member of the Society.

21st March, 1894.

The Ninth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 21st March, 1894, at Eight o'clock— Mr. F. T. Barrett, Member of Council, in the Chair.

1. The Minutes of the Eighth Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. William D. Sawers, Assoc.I.C., Analytical Chemist, 7 Buckingham Street, Hillhead, who was elected on 7th March, was admitted to the Membership of the Society.

3. Mr. W. B. Sayers, Assoc. Inst. E.E., read a paper on "Dynamo-Electric Machinery and some of its applications." The paper was very fully illustrated with the aid of current from the Corporation Electric Mains, and by lime-light views, &c. After a few remarks from Professor Jamieson and Mr. H. A. Mavor, a cordial vote of thanks was awarded to Mr. Sayers for his interesting communication. Thanks were also voted to the Convener of the Corporation Electric Lighting Committee, and to Mr. Arnot, the City Electrical Engineer.

4th April, 1894.

The Tenth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 4th April, 1894, at Eight o'clock—Dr. Joseph Coats, Vice-President, in the Chair.

1. The Minutes of the Ninth Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Captain M'Auslan, of the African Lakes Company's s.s. *Domira,* read a paper on "Nyasaland" *(a communication from the Geographical and Ethnological Section),* which was extensively illustrated by lime-light views. On the motion of the Chairman, seconded by Dr. George A. Turner, Captain M'Auslan was heartily thanked for his paper.

18th April, 1894.

The Eleventh Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 18th April, 1894, at Eight o'clock—Dr. James Colville, M.A.. Secretary of the Philological Section, in the Chair.

1. The Minutes of the Tenth Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. M. Hector Rey, B.L., B.Sc., read a paper on "The Girondists: An Episode in the French Revolution of 1789." The paper (which was a *communication from the Philological Section*) was extensively illustrated by lime-light views of men and women who took part in the Revolution and of some of the notable events in it, and was listened to by a very large audience, including many visitors. At the close, M. Rey received the thanks of the Society for his paper, on the motion of the Chairman.

2nd May, 1894.

The Twelfth Ordinary and Closing Meeting of the Philosophical Society of Glasgow for Session 1893-94 was held in the Society's Rooms, 207 Bath Street, on Wednesday, 2nd May, at Eight o'clock p.m.—Professor John Ferguson, LL.D., F.R.S.E., President, in the Chair.

1. The Minutes of the Eleventh Ordinary Meeting for Session 1893-94, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Professor Ferguson submitted the following communications:—(*a*) "Some Early Treatises on Technological Chemistry: Supplementary Paper;" (*b*) "Contributions to the History of Chemistry in France in the Seventeenth Century: Jean Beguin (John Beguinus)," for which he was awarded the thanks of the Society.

3. Mr. W. Hood Black, District Manager for the Edison-Bell Phonograph Corporation, by special request, exhibited, described, and gave some interesting demonstrations with, the Phonograph. His descriptive account of the instrument was supplemented by an interesting statement made by Dr. M'Kendrick. A very cordial vote of thanks was passed to Mr. Black for his description of the instrument and demonstrations made with it.

4. The Annual Reports by Secretaries of Sections were submitted by the Secretary of the Society, and ordered to be printed in the next volume of the Society's *Proceedings*.

5. The President then dismissed the Society for the Summer Recess.

OFFICE-BEARERS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

SESSION 1893-94.

President.

PROFESSOR JOHN FERGUSON, M.A., LL.D., F.R.S.E., F.C.S., F.S.A., F.S.A.Scot.

Vice-Presidents.

*CHARLES GAIRDNER, LL.D.
MR. WILLIAM LANG, JUN., F.C.S.
DR. JOSEPH COATS.

Honorary Vice-Presidents.

PROFESSOR THE RIGHT HON. LORD KELVIN, M.A., LL.D., D.C.L., Pres. R.S., Foreign Associate of the Institute of France, Hon. Vice-President R.S.E., and Member of the Prussian Order *Pour le Mérite*,
JAMES B. RUSSELL, B.A., LL.D., M.D.,
PROFESSOR JOHN GRAY M'KENDRICK, M.D., LL.D., F.R.S., F.R.S.E., F.R.C.P.E.,

MR. JOHN ROBERTSON, *Librarian.*
MR. JOHN MANN, C.A., *Treasurer.*
MR. JOHN MAYER, *Secretary.*

Presidents of Sections.

MR. CAMPBELL DOUGLAS, Architect, F.R.I.B.A., *Architectural Section.*
MR. JAMES CHALMERS, I.A., *Sanitary and Social Economy Section.*
SIR W. RENNY WATSON, *Geographical and Ethnological Section.*
LORD KELVIN, Pres. R.S., &c., *Mathematical and Physical Section.*
WILLIAM SMART, M.A., LL.D., *Economic Science Section.*
DAVID ROSS, M.A., B.Sc., LL.D., *Philological Section.*

Other Members of Council.

*MR. MAGNUS MACLEAN, M.A., F.R.S.E.
*DR. EBEN. DUNCAN.
*DR. GEORGE A. TURNER.
*MR. WILLIAM JOLLY, F.R.S.E., F.G.S.
DR. GEORGE G. HENDERSON, M.A.
MR. DAVID THOMSON, I.A.
MR. GILBERT THOMSON, M.A., C.E.
MR. F. T. BARRETT.
Ex-Bailie WALLACE.
PROF. BARR, C.E., D.Sc.
MR. H. A. MAVOR, M.I.E.E.
MR. A. SOMERVILLE, B.Sc., F.L.S.

* *Retire by rotation in November, 1894.*

COMMITTEES APPOINTED BY THE COUNCIL.

COMMITTEE ON FINANCE.

DR. J. G. M'KENDRICK, *Hon. Vice-President.*

MR. WILLIAM LANG. MR. WALLACE. MR. MAVOR.

MR. JOHN MANN, *Treasurer, Convener.*

MR. LANG, *Sub-Convener.*

COMMITTEE ON THE LIBRARY.

PROFESSOR FERGUSON, *President.*

MR. LANG,
DR. COATS, } *Vice-Presidents.*

MR. MACLEAN.	MR. JOLLY.
MR. C. DOUGLAS.	DR. TURNER.
DR. SMART.	MR. BARRETT.
PROF. BARR.	DR. HENDERSON.
MR. CHALMERS.	MR. G. THOMSON.

MR. JOHN ROBERTSON, *Librarian, Convener.*

"SCIENCE LECTURES" TRUST COMMITTEE.

PROFESSOR FERGUSON, *President.*

DR. M'KENDRICK.	MR. JOHN MAYER.
MR. BARRETT.	DR. E. DUNCAN.

DR. J. B. RUSSELL, *Convener.*

HOUSE COMMITTEE.

Consisting of Members of the Philosophical Society and of the Institution of Engineers and Shipbuilders.

Institution of Engineers and Shipbuilders.	*Philosophical Society.*
MR. JOHN INGLIS.	MR. LANG.
MR. DAVID J. DUNLOP.	MR. JOHN MANN.
MR. MATTHEW HOLMES.	MR. JOHN MAYER.

OFFICE-BEARERS OF SECTIONS.

ARCHITECTURAL SECTION.

President.

MR. T. L. WATSON, F.R.I.B.A., Architect.

Vice-Presidents.

MR. P. MACGREGOR CHALMERS, Architect, F.S.A.Scot.
MR. CHARLES CARLTON, Decorator.

Joint-Treasurers.

MR. JAMES HOWATT, Measurer.
MR. WILLIAM HOWATT, Measurer.

Secretary.

MR. A. LINDSAY MILLER, Architect, 122 Wellington Street.

Members of Council.

MR. CAMPBELL DOUGLAS, Architect.
MR. THOMAS GILDARD, Architect.
MR. R. D. SANDILANDS, Architect.
MR. D. MACBEAN, Architect.
MR. JAMES LINDSAY, Architect.
MR. JOHN A. CAMPBELL, Architect.
MR. W. P. BUCHAN, Sanitary Engineer.
MR. ANDREW BLACK, Smith.
MR. MALLOCH BAYNE, Glass Merchant.
MR. JAMES GRANT, Joiner.
MR. JAMES SMELLIE, Measurer.
MR. JAMES CAIRNS, Clerk of Works.

Hon. Members of Council.

MR. JOHN HONEYMAN, Architect.
MR. DAVID THOMSON, Architect.
MR. JAMES THOMSON, Architect.
MR. ALEXANDER MUIR, Builder.
MR. R. A. M'GILVRAY, Plasterer.

CHEMICAL SECTION.

(In abeyance.)

BIOLOGICAL SECTION.

(In abeyance.)

SANITARY AND SOCIAL ECONOMY SECTION.

MR. JAMES CHALMERS, I.A., *President.*

BAILIE CRAWFORD,
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Donations in addition to the Works received in Exchange from the Societies, &c., named on pp. 267-273.

Twenty-third Annual Report of the Operations of the Sanitary Department of the City of Glasgow for 1892. By Peter Fyfe. From the Author.

Twenty-ninth Annual Report on Alkali, &c., Works for 1892. From Mr. W. Salvador Carphey.

Geology of the Eureka Districts, Nevada, with Atlas. By Arnold Hague. Monograph, vol. 20. United States Geological Survey. From Smithsonian Institution.

Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey. By R. P. Whitfield. Monograph, vol. 18. United States Geological Survey. From Smithsonian Institution.

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NEW BOOKS RECENTLY ADDED TO THE LIBRARY BY PURCHASE.

Dictionary of National Biography. Vols. 35 to 39.

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Lilford's Birds of the British Islands. Parts 23 to 26.

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,, II.—Darwiniana.
,, III.—Science and Education.
,, IV.—Science and Hebrew Tradition.
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- Alumni Association.
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- American Philosophical Society.
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- Wagner Free Institute of Science.

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- Rochester Academy of Science.

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- Public School Library.

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- Kansas Academy of Science.

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- Trenton Natural History Society.

Washington—
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- Smithsonian Institution.
- United States Naval Observatory.
- United States Geological Survey.

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(Those received in exchange are indicated by an asterisk.)

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Academy.
Architect.
Athenæum.
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British Journal of Photography.
Builder.
Building News.
Chemical News.
Comptes Rendus.
Dingler's Polytechnisches Journal.
Economist.
Electrical Review.
Electrician.
Engineer.
*Engineering.
English Mechanic.
*Industries and Iron.
*Journal of the Society of Arts.
Journal of Gas Lighting, &c.
*Lancet.
Nature.
Notes and Queries.
*Pharmaceutical Journal.
Publishers' Circular.
Scientific American and Supplement.

FORTNIGHTLY.

Annalen der Chemie (Liebig's).
*Berichte der Deutschen Chemischen Gesellschaft.
Journal für Praktische Chemie (Erdmann's).
Zeitschrift für Angewandte Chemie.

MONTHLY.

*American Chemical Journal.
American Journal of Science.
Analyst.
Annalen der Physik und Chemie.
Annales de Chimie et de Physique.
Annales de l'Institut Pasteur.
Annales des Ponts et des Chaussées.
Annales des Sciences Naturelles. Botanique.
Annales des Sciences Naturelles. Zoologie.
Annals and Magazine of Natural History.
Antiquary.
Beiblätter zu den Annalen der Physik und Chemie.
*Boletin Mensuel d'Observatorio Meteorologico-Magnetico Central de Mexico.
Bookseller.
Bulletin de la Société Chimique de Paris.
Bulletin de la Société d'Encouragement.
Bulletin de la Société Géologique de France.
Bulletin de la Société Industrielle de Mulhouse.
*Bulletin Mensuel de l'Observatoire de Montsouris.
*Canadian Entomologist.
*Deutsche Kolonialzeitung.
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*Johns Hopkins University Circulars.
Journal de Pharmacie et de Chimie.
Journal of Botany.
*Journal of the Chemical Society.
*Journal of the Franklin Institute.
*Journal of the Photographic Society.
*Journal of the Society of Chemical Industry.
London, Edinburgh, and Dublin Philosophical Magazine.
*Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin.
Petermann's Mitteilungen.
Polytechnic Bibliothek.
*Proceedings of Royal Geographical Society.
*Proceedings of Royal Society of London.
*Proceedings of the Society of Biblical Archæology.
Revue Universelle des Mines.
*Royal Astronomical Society's Monthly Notices.
Sanitary Journal.
*Scottish Geographical Magazine.
Zoologist.

QUARTERLY.

Annales des Mines.
Annals of Botany.
*Archives Nèerlandaises des Sciences Exactes et Naturelles.
*Bulletin of the American Geographical Society.
Forschritte der Mathematik.
Grevillea.
Ibis.
Journal of Anatomy and Physiology.
*Journal of the Anthropological Institute of Great Britain.
*Journal of Manchester Geographical Society.

Journal of the Royal Agricultural Society of England.

*Journal of the Royal Statistical Society.

*Journal of the Scottish Meteorological Society.

La Nature.

Mind: a Quarterly Review of Psychology and Philosophy.

Quarterly Journal of Economics.

Quarterly Journal of Geological Society.

Quarterly Journal of Microscopical Science.

Quarterly Journal of Pure and Applied Mathematics.

*School of Mines Quarterly.

Scottish Naturalist.

*Sociedad Cientifica "Antonio Alzate."

Zeitschrift für Analytische Chemie.

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FOR 1893-94.

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	Ernst Heinrich Hæckel, Jena.	1880
	Louis Pasteur, Paris.	1885
	Georg Quincke, Heidelberg.	1890

AMERICAN AND COLONIAL.

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	Sir John William Dawson, LL.D., F.R.S., Principal of M'Gill College, Montreal.	1883
	Thomas Muir, M.A., LL.D., F.R.S.E., Superintendent General of Education, Cape Colony.	1892

BRITISH.

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10	The Right Hon. Thomas Henry Huxley, Ph.D., LL.D., D.C.L., F.R.S., Professor of Biology, Royal College of Science, London, Hodeslea, Eastbourne.	1876
	Herbert Spencer, care of Messrs. Williams & Norgate, 14 Henrietta street, Covent Garden, London.	1879
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	Sir George Gabriel Stokes, Bart., M.A., LL.D., D.C.L., F.R.S., M.P., Cambridge.	1887
15	F. Max Müller, M.A., Professor of Comparative Philology, Oxford.	1889
	The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., *Sec.*R.S., London, Terling Place, Witham, Essex.	1890

CORRESPONDING MEMBERS.

WITH YEAR OF ELECTION.

A. S. Herschel, M.A., D.C.L., F.R.S., F.R.A.S., Hon. Professor of Experimental Physics in the Durham College of Science, Newcastle-on-Tyne; Observatory House, Slough, Bucks. 1874

Thomas E. Thorpe, Ph.D., F.R.S., Professor of Chemistry in Royal College of Science, London. 1874

John Aitken, F.R.S., F.R.S.E., Darroch, Falkirk. 1883

Alex. Buchan, M.A., LL.D., F.R.S.E., Secretary to the Scottish Meteorological Society, 122 George street, Edinburgh. 1883

5 James Dewar, M.A., F.R.S., F.R.S.E., M.R.I., Jacksonian Professor of Physics, University of Cambridge, and Professor of Chemistry in the Royal Institution of Great Britain, 1 Scroope terrace, Cambridge. 1883

Stevenson Macadam, Ph.D., F.R.S.E., Lecturer on Chemistry, Surgeons' Hall, Edinburgh. 1883

Joseph W. Swan, M.A., F.R.S., Lauriston, Bromley, Kent. 1883

E. A. Wünsch, F.G.S., Carharrack, Scorrior, Cornwall. 1883

George Anderson, Master of the Mint, Melbourne. 1885

10 William Milne, M.A., B.Sc., F.R.S.E., Department of Public Education, Cradock, Cape Colony, ... 1894

ORDINARY MEMBERS.

WITH YEAR OF ENTRY.

* *Denotes Life Members.*

Adam, William, M.A., 235 Bath st. 1876

*Adam, Thomas, 27 Union street. 1892

Adams, William, 28 Ashton terrace, Dowanhill. 1891

Aikman, C. M., M.A., B.Sc., F.R.S.E., F.I.C., F.C.S., 128 Wellington street. 1886

5 Alexander, D. M., Marionville, Queen's drive. 1887

Alexander, G. W., M.A., 129 Bath street 1893

Alexander, Peter, M.A., 26 Smith street, Hillhead. 1885

Alexander, Thos., 48 Sardinia ter. 1869

Alston, J. Carfrae, 27 James Watt street. 1887

10 Anderson, Alexander, 157 Trongate. 1869

Anderson, James, 168 George street. 1890

Anderson, John, 22 Ann street. 1884

Anderson, Robert, 22 Ann street. 1887

Anderson, R. T. R., 618 Gallowgate street. 1889

15 *Anderson, T. M'Call, M.D., Professor of Clinical Medicine in the University of Glasgow, 2 Woodside terrace. 1873

*Anderson, William, 284 Buchanan street. 1890

Anderson, W. F. G., 47 Union street. 1878

Annan, J. Craig, 234 Sauchiehall st. 1888

Annandale, Charles, M.A., LL.D., 35 Queen Mary avenue. 1888

20 Arnot, James Craig, 162 St. Vincent street. 1869

*Arnot, J. L., 116 West Campbell st. 1890

Arnot, William, City Chambers. 1894

Atkinson, J. B., 10 Foremount terrace, Partick. 1889

Bain, Andrew, 18 Athole gardens. 1890

25 Bain, Sir James, F.R.S.E., 3 Park terrace. 1866

Bain, Robert, 132 West Nile street. 1869

*Baird, J. G. A., M.P., Wellwood, Muirkirk. 1892

Balloch, Robert, 131 St. Vincent st. 1843

Balmain, Thos., 1 Kew terrace, Kelvinside. 1881

30 Barbour, T. F., F.C.S., F.I.C., 35 Robertson street. 1891

Barclay, A. J. Gunion, M.A., F.R.S.E., High School. 1893

Barclay, A. P., 133 St. Vincent street. 1890

Barclay, George, 133 St. Vincent st. 1891

Barclay, James, 36 Windsor terrace. 1871

35 Barrett, Francis Thornton, Mitchell Library. 1880

Barr, Archibald, D.Sc., Professor of Civil Engineering and Mechanics, University of Glasgow, Royston, Dowanhill. 1890

*Barr, James, C.E., I.M., F.S.I., 221 West George street. 1883

Barr, Thos., M.D., F.F.P.S.G., 13 Woodside place, W. 1879

Bathgate, William, M.A., 13 Westbourne gardens. 1887

40 Bayne, A. Malloch, 13 Kelvin drive, Kelvinside. 1878

Beatson, George T., B.A. (Cantab.), M.D., 7 Woodside crescent. 1881

Begg, Wm., 636 Springfield road. 1883

*Beith, Gilbert, M.P., 7 Royal Bank place. 1881
Bell, Dugald, F.G.S., 27 Lansdowne crescent. 1871
45*Bell, Henry, 5 Cornwall terrace, Regent's Park, London, N.W. 1876
Bell, James, 101 St. Vincent street. 1877
Bell, Stuart, 41 Clyde place. 1893
Bennett, Robert J., Alloway park, Ayr. 1883
Biles, J. H., Professor of Naval Architecture and Marine Engineering, University of Glasgow. 1893
50 Bilsland, William, 28 Park circus. 1888
Binnie, J., Barassie, Troon. 1877
Black, D. Campbell, M.D., M.R.C.S.E., 121 Douglas street. 1872
Black, J. Albert. Duneira, Row. 1869
Black, John, 16 Park terrace. 1869
55 Black, Malcolm, M.D., 5 Canning place. 1880
*Blackie, J. Alexander, 17 Stanhope street. 1881
*Blackie, J. Robertson, 17 Stanhope street. 1881
Blackie, Robert, 17 Stanhope st. 1847
Blackie, W. G., Ph.D., LL.D., F.R.G.S., 17 Stanhope street. 1841
60*Blackie, Walter W., B.Sc., 17 Stanhope street. 1886
Blair, G. M'Lellan, 2 Lilybank ter. 1869
Blair, J. M'Lellan, Williamcraig, Linlithgowshire. 1869
Blair, Matthew, 11 Hampton Court terrace. 1887
Blyth, James, M.A., F.R.S.E., Professor of Natural Philosophy, Andersonian Buildings, 204 George street, *Vice-President.* 1881
65*Blyth, Robert, C.A., 1 Montgomerie quadrant. 1885
*Blythswood, The Rt. Hon. Lord, Renfrew. 1885
Borthwick, James D., 3 Balshagray terrace, Partick. 1891
Bottomley, James T., M.A., D.Sc., F.R.S., F.R.S.E., F.C.S., Demonstrator in Natural Philosophy, University of Glasgow, 13 University gardens, Hillhead, *Vice-President.* 1880
Bottomley, Wm., C.E., 15 University gardens. 1880
70 Bower, F. O., D.Sc., M.A., F.R.S., F.L.S., Regius Professor of Botany in the University of Glasgow, 45 Kersland terrace. 1885
Boyd, John, Shettleston Iron-works, near Glasgow. 1873
Brand, James, C.E., 172 Buchanan st. 1880
Brier, Henry, M.I.M.E., Scotch and Irish Oxygen Co., Polmadie. 1889
Brodie, John Ewan, M.D., C.M., F.F.P.S.G., 5 Woodside place. 1873
75 Brown, Alexander, 3 Queen's ter. 1887
*Brown, Hugh, 5 St. John's terrace, Hillhead. 1887
Brown, James, 76 St. Vincent st. 1876
*Brown, John, 11 Somerset place. 1881
Brown, Robert, 19 Jamaica street. 1882
80*Brown, Wm. Stevenson, 41 Oswald street. 1886
*Brown, William, 165 W. George st. 1892
Browne, Richard, Beechholm, Queen's drive, Crosshill. 1893
Browne, Robert, B.Sc., 45 Washington street. 1893
Brownlie, Archibald, Bank of Scotland, Barrhead. 1880
85 Brownlie, J. Rankin, L.D.S. (Eng.), 220 West George street. 1892
Brunton, Rev. Alex., Ardbeg villa, Craigpark, Dennistoun. 1884
*Bryce, Charles C., 141 West George street. 1884
Bryce, David, 129 Buchanan street. 1872
*Bryce, Robert, 82 Oswald street. 1886
90*Buchan, William P., 36 & 38 Renfrew street. 1875
Buchanan, Alex. M., A.M., M.D., Professor of Anatomy, Anderson's College Medical School, 98 St. George's road. 1876
Buchanan, George S., 85 Candleriggs. 1845
*Buchanan, William, 123 Blythswood drive. 1886
Burnet, John, I.A., 167 St. Vincent street. 1850
95 Burnet, John James, A.R.I.B.A., 18 University avenue. 1892
Burnet, Lindsay, Assoc. M.I.C.E., Boiler Works, Govan. 1882
Burns, J., M.D., 15 Fitzroy place, Sauchiehall street. 1864

*Caldwell, George B., Scotia Leather Works, Boden street. 1892
Callajon, Ventura De, 131 West Regent street. 1886
100 Callajon, Ventura De, jun., 131 West Regent street, 1891
Cameron, Sir Charles, Bart., M.D., LL.D., M.P., Greenock. 1870
Cameron, H. C., M.D., 200 Bath street. 1873
Cameron, John E., 115 Bothwell street. 1892
*Campbell, J. A., LL.D., M.P., Strathcathro, Brechin. 1848
105*Campbell, James, 137 Ingram st. 1885
Campbell, John D., Greenside, North avenue, Copeland road, Govan. 1858

*Campbell, John Ferguson, 15 Montgomerie street, N., Kelvinside. 1892
Campbell, John MacNaught, C.E., F.Z.S., F.R.S.G.S., Kelvingrove Museum. 1883
*Campbell, Louis, 3 Eton terrace, Hillhead. 1881
110 Campbell, Malcolm, 18 Gordon street. 1894
Campbell, Thomas, Maryhill Ironworks, 1894
Carlile, Thomas, 23 West Nile street. 1851
Carmichael, Neil, M.D., C.M., F. F. P. S. G., Invercarmel, 23 Nithsdale drive, Pollokshields. 1873
Carver, Thomas, A.B., B.Sc., C.E., 11 University. 1890
115 Cassells, John, 62 Glencairn drive, Pollokshields. 1890
*Cayzer, Charles W., 109 Hope street. 1886
Chalmers, A. K., M.D., D.P.H. (Camb.), 23 Kersland terrace. 1892
Chalmers, James, I.A., 93 Hope street. 1884
Chalmers, P. MacGregor, F.S.A.Scot., 176½ Hope street. 1891
120 Cherrie, James M., Clutha cottage, Tollcross. 1876
*Chisholm, Samuel, 4 Royal ter., W. 1890
*Christie, Henry W., Levenfield house, Alexandria. 1892
Christie, John, Turkey-red Works, Alexandria, Dumbartonshire. 1868
Chrystal, W. J., F.I.C., F.C.S., Shawfield Works, Rutherglen. 1882
125 Church, W. R. M., C.A., 75 St. George's place. 1885
Clapperton, Charles, 175 West George street. 1882
Clapperton, John, 9 Crown Circus drive. 1874
Clark, John, Ph.D., F.I.C., F.C.S., 138 Bath street. 1870
Clark, John, 9 Wilton crescent. 1872
130*Clark, William, 125 Buchanan st. 1876
Cleland, A. B. Dick, 15 Newton place. 1871
*Cleland, John, M.D., LL.D., D.Sc., F.R.S., Professor of Anatomy in the University of Glasgow. 1884
*Coats, Joseph, M.D., Professor of Pathology in the University of Glasgow, 31 Lynedoch street. 1873
*Cochran, Robert, 7 Crown circus, Dowanhill. 1877
135 Coghill, Wm. C., 263 Argyle street. 1873
Collins, Sir William, F.R.G.S., 3 Park terrace, East. 1869
Colquhoun, James, LL.D., 158 St. Vincent street. 1876
Colville, James, M.A., D.Sc., 14 Newton place. 1885
Connell, Wm., 42 St. Enoch square. 1870
140 Cooke, Louis H., A.R.S.M., 204 George street. 1893
Copland, Wm. R., M. Inst. C.E., F.S.I., 146 West Regent street. 1876
Core, William, M.D., Medical Superintendent, Barnhill Hospital. 1891
Coste, Jules, French Consulate, 131 West Regent street. 1888
Costigane, John T., Hampton house, Ibrox. 1889
145 Costigane, William, Clifton hall, Albert drive, Pollokshields. 1890
Coubrough, A. Sykes, Parklea, Blanefield, Strathblane. 1869
Coulson, W. Arthur, 57 West Nile street. 1888
Couper, James, Craigforth house, Stirling. 1862
Cowan, M'Taggart, C.E., 27 Ashton terrace, Hillhead. 1876
150 Craig, T. A., C.A., 139 St. Vincent street. 1886
Crawford, Wm. C., M.A., Lockharton gardens, Slateford, Edinburgh. 1869
Cree, Thomas S., 21 Exchange sq. 1869
Crichton, James, 201 Nithsdale road, Pollokshields. 1892
Crosbie, L. Talbot, Scotstounhill, Whiteinch. 1890
155 Cross, Alexander, M.P., 14 Woodlands terrace. 1887
Curphey, Wm. Salvador, 15 Bute mansions, Hillhead 1883
Cuthbert, Alexander A., 14 Newton terrace. 1885
*Cuthbertson, Sir John N., 29 Bath street. 1850

Dansken, A. B., 121 West George street. 1877
160*Dansken, John, I.M., F.S.I., F.R.A.S., 121 West Regent st. 1876
Darling, Geo. E., 178 St. Vincent st. 1870
Darwin, Harry, St. Andrew's Works, 618 Eglinton street. 1891
Deas, Jas., C.E., 7 Crown gardens, Dowanhill. 1869
Dempster, John, 4 Belmar terrace, Pollokshields. 1875
165 Dennison, William, C.E., 175 Hope street. 1876
Dick, George Handasyde, 136 Buchanan street. 1887
*Dixon, A. Dow, 10 Montgomerie crescent, Kelvinside. 1873
Dixon, Walter, 164 St. Vincent street. 1893
Dobbie, A. B., M.A., University. 1885

170 Dobson, James, Springfield avenue, Uddingston. 1892
Donald, John, Townhead Public School. 1872
Donald, William J. A., 70 Great Clyde street. 1877
Donaldson, James, Gas-works, Cambuslang. 1890
Dougall, Franc Gibb, 167 Canning street. 1875
175 *Dougall, John, M.D., C.M., F.F.P.S.G., Professor of Materia Medica, St. Mungo's College, 6 Belmar terrace, Pollokshields. 1876
Douglas, Campbell, I.A., F.R.I.B.A., 266 St. Vincent street. 1870
Downie, Robert, jun., Carntyne Dye-works, Parkhead. 1872
Downie, Thomas, Hydepark Foundry. 1886
Drew, Alex., 12 St. Vincent place. 1869
180 Duncan, Eben., M.D., C.M., F.F.P.S.G., Queen's Park house, Langside road. 1873
*Duncan, Robert, Whitefield Works, Govan. 1890
*Duncan, Walter, 7 West George st. 1881
*Dunlop, Nathaniel, 25 Bothwell street. 1870
Dunn, Robert Hunter, 4 Belmont crescent. 1878
185 Dyer, Henry, M.A., D.Sc., C.E., 8 Highburgh terrace, Dowanhill. 1883

Eadie, Alexander, 280 Cathcart road. 1885
Easton, William J., 150 West Regent street. 1876
*Edwards, John, Govanhaugh Dye-works, M'Neil street. 1883
Elgar, Francis, LL.D., 113 Cannon street, London, E.C. 1884
190 *Ellis, T. Leonard, North British Iron-works, Coatbridge. 1888
Erskine, Jas., M.A., M.B., L.F.P.S., 351 Bath street. 1886
*Ewing, Wm., 7 Royal Bank place. 1883

Fairweather, Wallace, C.E., 62 St. Vincent street. 1880
Falconer, Patrick, 33 Hayburn crescent, Partick. 1876
195 Falconer, Thos., 50 Kelvingrove st. 1880
Farquhar, John, 13 Belhaven ter. 1872
Farquhar, Wm. R., 13 Belhaven terrace. 1892
Faulds, W. B., Westfield, Ibrox. 1890
Fawsitt, Charles A., 9 Foremount terrace, Partick. 1879
200 Fergus, Freeland, M.D., F.F.P.S.G., 203 Bath street. 1887
Ferguson, D. Scott, 10 Belhaven terrace. 1890
*Ferguson, John, M.A., LL.D., F.R.S.E., Professor of Chemistry, University of Glasgow, *President*. 1869
Ferguson, Peter, 15 Bute gardens, Hillhead. 1866
Ferguson, Thomas, 124 Salamanca street, Parkhead. 1883
205 Fergusson, Alex. A., 48 M'Alpine street. 1847
Findlay, Joseph, Clairmont, Winton drive, Kelvinside. 1873
Finlayson, James, M.D., 2 Woodside place. 1873
*Fleming, James, 136 Glebe street. 1880
*Fleming, William James, M.D., 3 Woodside terrace. 1876
210 Fotheringham, T. B., 65 West Regent street. 1889
Foulis, William, C.E., 45 John st. 1870
*Fowler, John, 5 Derby street, Sandyford. 1880
Frame, James, Union Bank of Scotland, 113 King street, Tradeston. 1885
Fraser, Matthew P., 91 W. Regent street. 1887
215 Fraser, Melville, 31 St. Vincent place. 1890
Frazer, Daniel, 127 Buchanan st. 1853
Frew, Alex., C.E., 175 Hope street. 1876
Fullarton, J. H., M.A., B.Sc., Fishery Board Office, Edinburgh. 1886
Fulton, David, Roxburgh villa, Bothwell. 1891
220 Fulton, R. C., 2 Lugar place, Kelvinside. 1890
Fyfe, Henry B., 115 St. Vincent street. 1892

Gairdner, Charles, LL.D., Broom, Newton-Mearns, *Vice-President*. 1884
*Gairdner, C. D., C.A., 115 St. Vincent street. 1886
Gairdner, W. T., M.D., LL.D., F.R.S., Professor of Practice of Medicine in the University of Glasgow, 225 St. Vincent street. 1863
225 Galbraith, Peter, 17 Huntly gardens. 1889
Galbraith, Walter M., 7 Holyrood crescent. 1893
Gale, James M., C.E., 45 John st. 1856
Galloway, T. Lindsay, C.E., 43 Mair street, Plantation. 1881
Gardner, Daniel, 36 Jamaica street. 1869
230 *Garrow, James R., 32 Elmbank crescent. 1890
*Garroway, John, 694 Duke st. 1875
Geddes, Wm., 8 Battlefield crescent, Langside. 1846

Gillies, W. D., 17 Royal Exchange square. 1872
Gilfillan, Wm., 129 St. Vincent st. 1881
235 Glaister, John, M.D., F.F.P.S.G., D.P.H., Camb., &c., Professor of Medical Jurisprudence and Public Health, St. Mungo's College, 4 Grafton place. 1879
Goldie, James, 40 St. Enoch square. 1883
Goodwin, Robert, 58 Renfield street. 1875
Gorman, C. S., Beechwood, Mount Vernon. 1890
Gourlay, John, C.A., 24 George square. 1874
240 Gow, Leonard, 19 Waterloo street. 1889
Gow, Leonard, jun., 19 Waterloo street. 1884
Gow, Robert, Cairndowan, Dowanhill gardens. 1860
Graham, Alex. M., Rowanlea, 7 St. Andrew's drive, Pollokshields. 1887
Graham, Robert, 108 Eglinton st. 1888
245 *Graham, William, 11 Claremont terrace. 1885
Gray, Andrew, 30 Bath street. 1889
Gray, James, M.D., 15 Newton terrace. 1863
Greenlees, Alex., M.D., 2 Havelock terrace, Paisley road. 1864
Grieve, John, M.A., M.D., F.R.S.E., care of W. L. Buchanan, 212 St. Vincent st. 1856
250 Guthrie, John, 50 M'Culloch st. 1891

Halket, George, M.D., F.F.P.S.G., 4 Royal cres., W. 1889
Hamilton, Don., Brandon, Uddingston. 1894
*Hamilton, John, I.A., 212 St. Vincent street. 1885
Harley, George, 29 Burnbank gar. 1891
255 *Harvie, John, Secretary, Clydesdale Bank, 30 St. Vincent place. 1880
Harvie, William, 8 Bothwell terrace, Hillhead. 1888
Hay, Alexander, 56 George square. 1892
Hedderwick, Maxwell, 3 Woodside place. 1892
Henderson, Alex., Barnhill Poorhouse. 1894
260 *Henderson, A. P., 20 Newton place. 1880
Henderson, George G., D.Sc., M.A., F.I.C., F.C.S., Professor of Chemistry, Glasgow and West of Scotland Technical College, 204 George street. 1883
Henderson, John, 38 Berkeley st. 1893
*Henderson, John, jun., Meadowside Works, Partick. 1879
Henderson, John, Towerville, Helensburgh. 1890
265 Henderson, Robert, 167 West Regent street. 1885
*Henderson, Wm., 15 Cadogan st. 1873
Hendrick, James, B.Sc., F.C.S., 60 John street. 1893
Henry, R. W., 62 Kelvingrove street. 1875
Heys, Zechariah J., South Arthurlie, Barrhead. 1870
270 Higgins, Henry, jun., 247 St. Vincent street. 1878
Hodge, William, 27 Montgomerie drive, Kelvinside. 1878
Hogg, Robert, 9 Nithsdale drive, Pollokshields. 1865
Honeyman, John, F.R.I.B.A., 140 Bath street. 1870
Horton, William, Birchfield, Mount Florida. 1889
275 Howat, William, 37 Elliot street. 1885
Howatt, James, I.M., 146 Buchanan street. 1870
Howatt, William, I. M., 146 Buchanan street. 1870
Hunt, Edmund, 87 St. Vincent st. 1856
*Hunt, John, Milton of Campsie. 1881
280 *Hunter, Wm. S., 30 Hope street. 1889
Hutchison, Peter, 3 Lilybank terrace, Hillhead. 1889

Inglis, R. A., Culrain, Bothwell. 1889

*Jack, William, M.A., LL.D., Professor of Mathematics in the University of Glasgow. 1881
Jamieson, Andrew, F.R.S.E., M.Inst.C.E., M.Inst.E.E., &c., Professor of Engineering, 16 Rosslyn terrace, 1881
285 Jenkins, Thomas Wilson, M.A., M.D., 232 Kenmure street. 1892
Johnston, David, 160 West George street. 1891
Johnstone, Jas., Coatbridge street, Port-Dundas. 1869
Jolly, William, F.G.S., F.R.S.E., Greenhead house, Govan. 1890

Kay, Wm. E., F.C.S., Gowanbank, Clarkston, Busby. 1887
290 Kean, James, 32 Scotia street, Garnethill. 1888
Kelly, James K., M.D., F.F.P.S.G., Park villa, Queen Mary avenue, Crosshill. 1889
*Kelvin, The Right Hon. Lord, LL.D., D.C.L., P.R.S., F.R.S.E., Professor of Natural Philosophy, University of Glasgow, *Hon. Vice-President*. 1846
Kennedy, James, 33 Greendyke street. 1889

Ker, Charles, M.A., C.A., 115 St. Vincent street. 1885
295*Ker, Wm., 1 Windsor ter., west. 1874
Kerr, Adam, 175 Trongate. 1887
Kerr, Charles James, 40 West Nile street. 1877
Kerr, Geo. Munro, 97 Buchanan street. 1890
Kerr, John G., M.A., 15 India street. 1878
300 Key, William, 109 Hope street 1877
King, James, 57 Hamilton drive, Hillhead. 1848
King, Sir James. Bart., LL.D., of Campsie, 115 Wellington street. 1855
King, John Y., 142 St. Vincent street. 1893
Kirk, Robert, M.D., Newton cottage, Partick. 1877
305 Kirkpatrick, Alexander B., 88 St. Vincent street. 1885
Kirkpatrick, Andrew J., 179 West George street. 1869
Kirkwood, James, Carling lodge, Ibrox. 1890
Knight, James, M.A., B.Sc., 121 Kenmure street, Pollokshields. 1893
Knox, Adam, 47 Crownpoint road. 1881
310*Knox, David J., 19 Renfield street. 1890
Knox, John, 58 Bath street. 1883

Laird, George H., 159 Greenhead street. 1882
Laird, John, Marchmont, Port-Glasgow. 1876
Laird, John, Royal Exchange Sale Rooms. 1879
315 Lamb, Thomas, 220 Parliamentary road. 1870
Lamond, Robert, 8 Marchmount terrace, Kelvinside. 1894
Lang, William, F.C.S., Crosspark, Partick, *Vice-President.* 1865
Latta, James, 73 Mitchell street. 1869
*Lauder, James, F.R.S.L., Glasgow, Athenæum. 1892
320 Lauder, John, 87 Union street. 1894
Leitch, Alexander, 60 Rosebank terrace, Grant street. 1886
Leslie, John A., jun., 48 Cadogan street. 1894
*Lindsay, Archd. M., M.A., 87 West Regent street. 1872
Lothian, Alex., V., 7 Huntly terrace, Kelvinside. 1893
325 Love, James Kerr, M.D., C.M., 10 Newark drive 1888
Lundholm, C. O., Nobel's Explosives Factory, Ardeer, Stevenston. 1890

M'Ara, Alex., 65 Morrison street. 1888
MacArthur, J. G., Rosemary villa, Bowling. 1874
*MacArthur, John S., 13 West Scotland street. 1890
330 M'Call, Samuel, 16 Hillsborough square, Hillhead. 1882
M'Callum, Robert, jun., 69 Union street. 1891
*M'Clelland, Andrew Simpson, C.A., 4 Crown gardens, Dowanhill. 1884
M'Conville, John, M.D., 27 Newton place. 1870
M'Cracken, James, 5 Bowmont terrace, Kelvinside. 1889
335 M'Crae, John, 7 Kirklee gardens, Kelvinside. 1876
M'Creath, James, M.E., 208 St. Vincent street. 1874
M'Culloch, Hugh, 154 West Regent street. 1880
Macdonald, Archibald G., 8 Park circus. 1869
Macdonald, Thomas, 205 St. Vincent street. 1869
340 Macdonald, Thomas F., M.B., C.M., Burgh house, Maryhill. 1889
Macfarlane, Walter, Crosslea house, Thornliebank. 1869
*Macfarlane, Walter, 12 Lynedoch crescent. 1885
M'Farlane, Wm., Edina lodge, Rutherglen. 1888
*M'Gilvray, R. A., 129 West Regent street. 1880
345 M'Gregor, Duncan, F.R.G.S., 37 Clyde place. 1867
M'Gregor, James, 1 East India avenue, London, E.C. 1872
M'Houl, David, Ph.D., Dalquhurn Works, Renton. 1883
*Macindoe, Alex., C.A., 32 Westbourne gardens. 1894
Macintosh, Donald J., M.B., C.M., Western Infirmary. 1894
350 M'Intyre, Wm., Marion bank, Rutherglen. 1888
Mackay, John Yule, M.D., University College, Dundee, 1885
M'Kechnie, Robert, 11 Royal Exchange square. 1893
M'Kellar, J., 25 Kelvinside ter., 1893
*M'Kenzie, W. D., 43 Howard st. 1875
355*M'Kenzie, W. J., 1 Oakfield ter., Hillhead. 1879
*M'Kendrick, John G., M.D., C.M., LL.D., F.R.S., F.R.S.E., F.R.C.P.E., Professor of Institutes of Medicine in the University of Glasgow, 2 Florentine gardens, *Hon. Vice-President.* 1877
Mackinlay, David, 6 Great Western terrace, Hillhead. 1855

*Mackinlay, James Murray, 4 Westbourne gardens. 1886
Mackinlay, Wm., 2 Belmont crescent., Hillhead. 1887
360 M'Kissack, John, 68 West Regent street. 1881
Maclae, A. Crum, 147 St. Vincent street. 1884
*Maclay, David T., 169 W. George street. 1879
Maclay, W., Eildon villas, Mount Florida. 1893
Maclean, A. H., 8 Hughenden terrace, Kelvinside. 1870
365 Maclean, Magnus, M.A., F.R.S.E., 8 St. Albans terrace, Hillhead. 1885
MacLehose, James J., M.A., 61 St. Vincent street. 1882
*Macleod, A., 3 Dundas street. 1893
M'Lennan, James, 40 St. Andrew's street. 1888
Macouat, R. B., 37 Elliot street 1885
370 Macphail, Donald, M.D., Garturk cottage, Whifflet, Coatbridge. 1877
M'Pherson, George L., 30 Albert road, Crosshill, East. 1872
M'Vail, D. C., M.B., 3 St. James' terrace, Hillhead. 1873
Machell, Thomas, 39 Great Western road. 1886
Main, Robert B., Broompark, Ardrossan. 1885
375 Mann, John, C.A., 188 St. Vincent street, *Treasurer*. 1856
Mann, John, jun., M.A., C.A., 188 St. Vincent street. 1885
Manwell, James, The Hut, 4 Albert drive, Pollokshields. 1876
Marshall, T. Rhymer, D.Ac., Professor of Chemistry in St. Mungo's College. 1894
Martin, William, 116 St. Vincent street. 1892
380 Martin, William, 4 North court, Royal Exchange square. 1894
Martin, W. C., 342 Argyle street. 1889
Marwick, Sir J. D., LL.D., F.R.S.E., 19 Woodside terrace. 1878
Mathieson, Thomas A., 3 Grosvenor terrace. 1869
Mavor, Alfred E., Victoria mansions, 32 Victoria street, London, S.W. 1890
385 Mavor, Henry A., 57 West Nile st. 1887
Mavor, James, 63 Bank street, Hillhead. 1885
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Mayer, John, Strathview, Cathkin road, Langside, *Secretary*. 1860
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390 Mechan, Henry, 60 Elliot street. 1879
Meikle, Andrew W., M.A., Viewfield house, Pollokshields. 1890
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*Menzies, Thos. J., M.A., B.Sc., F.C.S., 211 Crown street, S.S. 1887
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395 Miller, A. Buchanan, 13 North Claremont street. 1891
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*Miller, Arch. Russell, 28 Lilybank gardens, Hillhead. 1884
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*Miller, George, Winton drive, Kelvinside. 1881
400 Miller, G. J., Frankfield, Shettleston. 1888
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*Miller, Thos. P., Cambuslang Dyeworks. 1864
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405 Mills, Edmund J., D.Sc., F.R.S., "Young" Professor of Technical Chemistry, 60 John street. 1875
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*Mirrlees, William J., 42 Aytoun road, Pollokshields. 1889
*Mitchell, George A., 63 Bath street. 1883
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410 *Moffatt, Alexander, 23 Abercromby place, Edinburgh. 1874
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*Mond, Robert Ludwig, B.A. (Cantab), F.R.S.E., 20 Avenue road, Regent's park, London, N.W. 1890
*Monteith, Robert, Greenbank, Dowanhill gardens. 1885
415 Moore, Alexander, C.A., 209 West George street. 1869
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420 *Muir, Allan, 183 George street. 1881
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*Muirhead, Andrew Erskine, Cart Forge, Crossmyloof. 1873

Muirhead, James, 10 Doune gardens, Kelvinside. 1887
425 *Muirhead, Robert F., M.A., B.Sc., 11 Hatton place, Edinburgh. 1879
Munro, Daniel, F.S.I., 10 Doune terrace, Kelvinside. 1867
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Munsie, Robert George, 10 Berkeley terrace, West. 1883
430 Murdoch, George, 40 St. Vincent place. 1894
*Murdoch, Robert, 19 Commerce st. 1880
Murdoch, Thomas, 115 Bothwell street. 1892
*Murray, David, LL.D., 169 West George street. 1876
Murray, John Bruce, 24 George square. 1890
435 Murray, A. Erskine, Sheriff-Substitute of Lanarkshire, Sundown, Montgomerie drive. 1881
Murrie, James, 264 St. Vincent st. 1892

Napier, Alex., M.D., F.F.P.S.G., Rose Bank, Queen Mary avenue, Crosshill. 1886
Napier, James, 15 Prince's square, Strathbungo. 1870
*Napier, John, 23 Portman square, London. 1846
440 Nelson, Alex., 80 Gordon street. 1880
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*Newlands, Joseph F., 28 Renfield st. 1883

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445 Osborne, Alex., 5 Oakley terrace, Dennistoun. 1870
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*Parker, John Dunlop, C.E., 146 West Regent street. 1889
450 *Parnie, James, F.S.I., 32 Lynedoch street. 1874
*Paterson, Robert, C.A., 28 Renfield street. 1881
Paton, James, F.L.S., Corporation Galleries, and Kelvingrove Museum. 1876
Patrick, Joseph, M.A., C.A., 203 West George street 1893
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455 Petrie, Alexander, I.A., 134 Wellington street. 1885
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*Pirrie, Robert, 9 Buckingham ter. 1875
*Pollock, R., M.B., C.M., F.F.P.& S.G., Laurieston house, Pollokshields. 1883
Pride, David, M.D., Townhead House, Neilston. 1887
460 Prince, Edward E., B.A. (Cantab), F.L.S., Professor of Zoology, St. Mungo's College. 1892
Pringle, Patrick James, 115 Mains street. 1892
*Provan, James. 40 West Nile st. 1868
Provand, A. D., M.P., 8 Bridge street, London, S.W. 1888

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465 Ramsay, Robert, M.D., L.R.C.S.E., Lochwinnoch. 1881
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Rattray, William A., 233 Hope st. 1890
470 Reid, Andrew, Houston place, S.S. 1875
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*Reid, Hugh, Belmont, Springburn. 1880
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475 Reid, Thos., M.D., 11 Elmbank st. 1869
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*Reid, William L., M.D., 7 Royal crescent, West. 1882
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480 Rey, Hector, B.L., B.Sc., 2 Vinicombe street, Hillhead. 1889
Richmond, Thos., L.R.C.P.E., 2 West Garden street. 1887
Ritchie, George, Parkhead Forge and Steel Works. 1890
Robertson, John, Woodside school, Endcliffe, Langside, *Librarian.* 1860
Robertson, J. M'Gregor, M.A., M.B., C.M., 26 Buckingham ter., Hillhead. 1881
485 Robertson, Robert, Coplawhill, Pollokshaws road. 1877
Robertson, Robert A., 8 Park street, East. 1877
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Robertson, William, C.E., 123 St. Vincent street. 1869
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490 Rose, Alexander, Richmond house, Dowanhill. 1879

*Rose, Charles A., 1 Belhaven cres. 1889
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*Ross, John, 9 Westbourne gardens. 1885
495 Ross, John Munn, C.A., 115 Wellington street. 1894
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500 Rundell, R. Cooper, Underwriters' Room, Royal Exchange. 1877
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Salmon, W. Forrest, F.R.I.B.A., 197 St. Vincent street. 1870
Sawers, Wm. D., Assoc. I.C., 7 Buckingham street, Hillhead. 1894
Sayers, William Brooks, 57 West Nile street. 1890
505 Schmidt, Alfred, 508 New City road. 1881
Scott, Alex., 2 Lawrence place, Dowanhill. 1871
*Scott, D. M'Laren, 2 Park quadrant. 1881
Scott, John, 140 Douglas street. 1891
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510 Scott, Robt., I.M., 115 Wellington street. 1884
Seligmann, Hermann L., 24 George square. 1850
Sexton, A. Humboldt, F.C.S., F.I.C., F.R.S.E., Professor of Metallurgy, Glasgow and West of Scotland Technical College, 204 George street. 1892
Shields, Thomas, M.A., Royal Indian Engineering College, Cooper's hill, Staines. 1890
Simons, Michael, 206 Bath street. 1880
515 Sinclair, Alexander, Ajmere lodge, Langside. 1883
Sloane, F. N., C.A., 187 West George street. 1893
Smart, William, M.A., LL.D., Nunholm, Dowanhill. 1886
Smellie, George, I.M., 167 St. Vincent street. 1880
*Smellie, Thos. D., F.S.I. 209 St. Vincent street. 1871
520 Smith, D. Johnstone, C.A., 149 W. George street. 1888
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Smith, Harry J., Ph.D., Coltness Iron-works, Newmains. 1877
Smith, Hugh C., 55 Bath street. 1861
Smith, James, LL.D., St. Peter's Lodge, Uddingston. 1892
525*Smith, J. Guthrie, 54 West Nile st. 1875
*Smith, Robert B., Bonnybridge, Stirlingshire. 1884
Snodgrass, James, F.C.S., 2 Keir terrace, Pollokshields. 1878
Snodgrass, William, M.A., M.B., C.M., Muirhead Demonstrator of Physiology, University of Glasgow, 11 Victoria crescent, Dowanhill. 1890
*Somerville, Alexander, B.Sc., F.L.S., 4 Bute Mansions, Hillhead street, Hillhead. 1888
530 Sorley, Robert, 3 Buchanan st. 1878
Spencer, Charles L., Edgehill, Kelvinside. 1891
Spens, John A., 169 W. George st. 1879
*Spiers, John, 43 Great Western road, Hillhead. 1885
Stanford, Edward C. C., F.C.S., Glenwood, Dalmuir, Dumbartonshire. 1864
535*Steel, William Strang, Philiphaugh, Selkirk. 1889
*Stephen, John, Domira, Partick. 1880
*Steven, Hugh, Westmount, Montgomerie drive. 1869
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*Stevenson, D. M., 12 Waterloo street. 1889
540*Stevenson, Jas., F.R.G.S., 23 West Nile street. 1870
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Stevenson, John, 12 Victoria road, Lenzie. 1892
Stevenson, Wm., 21 Clyde place. 1888
Stewart, Andrew, 41 Oswald street. 1887
545 Stewart, Archibald, Marnock villa, Queen's drive, Crosshill. 1892
Stewart, David, 3 Clifton place. 1856
Stewart, James, 2 Lawrence place, Dowanhill. 1891
Stewart, James Reid, 30 Oswald street. 1845
Stewart, John, Western Saw Mills. 1877
550 Stobo, Thomas, Somerset house, Garelochhead. 1884
Stoddart, James Edward, Howden, Mid-Calder, N.B. 1872
*Strain, John, C.E., 154 West George street. 1876
*Sutherland, David, Royal Marine Hotel, Nairn. 1880
*Sutherland, John, Great Western Hotel, Oban. 1880
555 Sutherland, J. R., C.E., 45 John street. 1884
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Tatlock, John, F.I.C., 13 Parkgrove terrace, West, Sandyford. 1875
Tatlock, Robt. R., F.R.S.E., F.I.C., F.C.S., 156 Bath street. 1868
Taylor, Benjamin, F.R.G.S., 10 Derby crescent, Kelvinside. 1872
560 Teacher, Adam, 14 St. Enoch sq. 1868
Teague, Francis, M.I.E.E., Electric Lighting Station, Coatbridge. 1894
Tennant, Sir Charles, Bart., 195 West George street. 1868
Tennent, Gavin P., M.D., 159 Bath street. 1875
Thomas, Moses, M.D., Superintendent, Royal Infirmary. 1890
565 Thomson, David, I.A., F.R.I.B.A., 2 West Regent street. 1869
Thomson, George C., F.C.S., 23 Kersland terrace, Hillhead. 1883
Thomson, Gilbert, M.A., C.E., 75 Bath street. 1885
Thomson, Graham Hardie, 2 Marlborough terrace, Kelvinside. 1869
*Thomson, James, F.R.I.B.A., 88 Bath street. 1886
570 Thomson, James M., Glen Tower, Kelvinside. 1892
Townsend, C. W., Crawford street, Port-Dundas. 1890
Tullis, David, St. Ann's Leather Works, Bridgeton. 1894
*Tullis, James Thomson, Anchorage, Burnside, Rutherglen. 1883
*Turnbull, John, jun., M.I.M.E., 18 Blythswood square. 1883
575 Turner, George A., M.D., 1 Clifton place, Sauchiehall street. 1883
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Ure, William P., Regent Mills, Sandyford. 1893

Verel, Wm. A., Fairholm, Larkhall. 1883

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580*Walker, Archibald, B.A. (Oxon.), F.C.S., 8 Crown ter., Dowanhill. 1885
Walker, Malcolm M'N., F.R.A.S., 7 Westbourne ter., Fort Matilda, Greenock. 1853
*Wallace, Hugh, 30 Havelock street. 1879
*Wallace, Wm., M.A., M.B., C.M., Westfield house, Shawlands. 1888
Wallace, William, M.A., Allan Glen's School. 1890
585 Warren, John A., C.E., 115 Wellington street. 1887
Watkinson, Wm. H., Whit. Sch., M.Inst.Mech.E., Professor of Steam and Steam Engines in the Glasgow and West of Scotland Technical College. 1893
Watson, Archibald, 5 Westbourne terrace. 1881
Watson, James, 25 Sandyford pl. 1873
*Watson, John, 205 West George st. 1886
590 Watson, Joseph, 225 West George st. 1882
*Watson, J. Robertson, M.A., Professor of Chemistry, Anderson's College Medical School. 1891
*Watson, Thomas Lennox, I.A., F.R.I.B.A., 108 W. Regent st. 1876
*Watson, Sir William Renny, 16 Woodlands terrace. 1870
Welsh, Thomas M., 3 Prince's gardens, Dowanhill. 1883
595 Wenley, James A., Bank of Scotland, Edinburgh. 1870
Westlands, Robert, 4 Dixon street. 1869
Whyte, A. C., L.D.S., 42 Dundas street. 1892
Whyte, James, 62 Robertson street. 1893
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600 Whitson, Alexander, jun., 7 Windsor quadrant, Kelvinside. 1893
*Whitson, Jas., M.D., F.F.P.& S.G., 13 Somerset place. 1882
*Whitelaw, Thomas N., 87 Sydney street. 1892
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605 Williamson, John, 65 West Regent street. 1881
Wilson, Alex., Hydepark Foundry, 54 Finnieston street. 1874
Wilson, David, Carbeth, by Killearn. 1850
Wilson, Robert, Treasurer, Glasgow Water Trust. 1893
Wilson, William, Virginia buildings. 1881
610 Wilson, William, Lord Carlisle's School, Bulmer, York. 1889
Wilson, W. H., 21 Hope street. 1881
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*Wingate, John B., 7 Crown terrace, Dowanhill. 1881
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615 Wingate, Walter E., 4 Bowmont terrace. 1880
Wood, James, M.A., Glasgow Academy. 1885
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Wood, Wm. Copland, Turkey-red Works, Alexandria. 1883
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620*Wood, Wm. Jas., 38 Cochrane st. 1893
Woodburn, J. Cowan, M.D., 197 Bath street. 1869

Yellowlees, D., M.D., LL.D., Physician-Superintendent, Gartnavel. 1881

Young, John, 2 Montague terrace, Kelvinside. 1885

Young, John, 64 Cochrane street. 1881

625 *Young, John, jun., M.A., B.Sc., 38 Bath street. 1887

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*Young, Thos. Graham, Westfield, West Calder. 1880

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